Artillery in and around the Latin East

(1097-1291)

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Summary

This study examines the development of artillery used in and around the Latin East during the period of the crusades. It begins with an examination of the broader historiography of medieval artillery, an overview of the spread of swing-beam siege engines (trebuchets) across Europe and the Levant in the Early Middle Ages, and the mechanical physics that govern such machines. From these foundations, the development and significance of the engines are investigated. Incorporating as much textual and archaeological evidence as possible, the use of artillery by Frankish and Muslim forces is examined on a case-by-case basis. With an appreciation of the power of these machines, the influence of artillery on the design of twelfth- and thirteenth-century-fortifications is analysed.

Both Frankish and Muslim forces were familiar with the traction trebuchet by the end of the eleventh century. While these engines remained relatively light throughout the period of the crusades, the counterweight trebuchet appears to have been introduced by the end of the twelfth century. Initially rather primitive and little stronger than the traction variety, these engines developed fairly quickly. The appearance of new vocabulary for identifying these engines in the early thirteenth century indicates their increasing strength and physical evidence from the middle of the century confirms that they had become much more powerful by the start of the Mamluk period. Although counterweight trebuchets appear to have grown steadily throughout the thirteenth century, these had a relatively limited impact on the design of most fortifications. Trebuchets, large and small, were an important part of Frankish and Muslim siege arsenals in the twelfth and thirteenth centuries, but even the largest were not effective breaching engines by the time the Franks were pushed out of the Holy Land.

Declaration

This work has not been submitted in substance for any other degree or award at this or any other university or place of learning, nor is being submitted concurrently in candidature for any degree or other award.

Signed: Michael Fulton

Date: 29 January 2016

This thesis is being submitted in partial fulfillment of the requirements for the degree of PhD

Signed: Michael Fulton

Date: 29 January 2016

This thesis is the result of my own independent work/investigation, except where otherwise stated.
Other sources are acknowledged by explicit references. The views expressed are my own.

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Date: 29 January 2016

I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loans **after expiry of a bar on access previously approved by the Academic Standards & Quality Committee.**

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Contents

Abbreviations

BL	British Library
BNF	Bibliothèque Nationale de France
CCCM	*Corpus Christianorum, Continuatio Mediaeualis*. 1966-
CSCO, Scr. Syri	*Corpus Scriptorum Christianorum Orientalium, Scriptores Syri*
DRHC	*Documents Relatifs à l'Histoire des Croisades*. Paris, 1946-
FRA	*Fontes rerum austriacarum*. Vienna, 1855-
Loeb	*Loeb Classical Library Series*
MGH SS	*Monumenta Germaniae Historica: Scriptores*. Ed. Georg Heinrich Pertz, et al. Societas Aperiendis Fontibus Rerum Germanicarum Medii Aevi. Hanover, et al., 1826-
MGH SRG	*Monumenta Germaniae Historica: Scriptores Rerum Germanicarum [nova series]*. Ed. Georg Heinrich Pertz, et al. Societas Aperiendis Fontibus Rerum Germanicarum Medii Aevi. Hanover, et al., 1826-
MGH SRG (s.e.)	*Monumenta Germaniae Historica: Scriptores Rerum Germanicarum [separatim editi]*. Ed. Georg Heinrich Pertz, et al. Hanover, et al., 1826-
PO	*Patrologia Orientalis*. Ed. R. Graffin and F. Nau. Paris, 1907-
PPTS	*Palestine Pilgrims' Text Society Library*. 13 vols. London, 1890-97
RHC	*Recueil des Historiens des Croisades*. 16 vols. Académie des Inscriptions et des Belles-Lettres. Paris, 1841-1906
Ar	*Documents Arméniens*. 2 vols. Académie des Inscriptions et des Belles-Lettres. Paris, 1869-1906
Lo	*Les Assises de Jérusalem*. 2 vols. Académie des Inscriptions et des Belles-Lettres. Paris, 1841-43
Oc	*Historiens Occidentaux*. 5 vols. Académie des Inscriptions et des Belles-Lettres. Paris, 1844-95
Or	*Historiens Orientaux*. 5 vols. Académie des Inscriptions et des Belles-Lettres. Paris, 1872-1906
RHGF	*Recueil des historiens des Gaules et de la France*. Ed. Martin Bouquet, et al. 24 vols. Paris, 1738-1904
RS	*Rerum Britannicarum Medii Aeui Scriptores, or Chronicles and Memorials of Great Britain and Ireland in the Middle Ages* (Rolls Series). 99 vols. London, 1858-97
SI	Istituto/Fonti per la Storia d'Italia
SHF	Société de l'Histoire de France

Maps

Plans

Photographs and Drawings

Images of Artillery

HISTORICAL IMAGES[1]

[1] The dating and place of composition are those provided by the curators of each document, unless otherwise stated, with the exception of the William of Tyre manuscripts that have been dated according to the analysis of Edbury, Folda and Buchthal, see Edbury, "The French Translation of William of Tyre's *Historia*," pp. 69-105; Folda, *Crusader Manuscript Illumination*; Buchthal, *Miniature Painting in the Latin Kingdom of Jerusalem*.

RECONSTRUCTED ENGINES

Names

Place names used in this study	Alternatives
Ajlun	al-Rabad
Akkar	*Gibelacar* / Akkar al'Ariqa
Apamea	Afamiya / al-Mudiq
Arima	'Areime
Arqa	Arcas
Arsuf	*Arsur*
Ashdod	Minat al-Qal'a
'Atlit	*Pelerin* / *Peregrinorum*
Baghras	*Gaston*
Baysan	Beit She'an
Beaufort	*Belfort* / Shaqif Arnun
Belmont	Suba
Belvoir	Kawkab
Bethgibelin	*Beit Gibelin* / Bait Jibrin
al-Bira	Birecik
Blanchegarde	Tell as-Safi
Bourzey	Qal'at Barza, *Rochefort* (likely the same)
Caco	Qaqun
Cafarlet	Kafr Lam
Castellum Regium	*Chateau de Roi* / Mi'ilya
Castle of Figs	*Castrum Ficuum* / Qal'at al-Burj
Castrum Arnoldi	Yalu
Chastel Blanc	Safita
Chastel Neuf	Hunin
Chastel Rouge	*Castrum Rubrum* / Yahmur
Crac des Chevaliers	Hisn al-Akrad
Cursat	al-Qusayr / az-Zau
Darum	Dair al-Balah
Jabala	*Gibellum* / *Gabula*
Jubayl	*Giblet /* Byblos
al-Habis	Petra
Habis Jaldak	*Cave de Suet* / 'Ain al-Habis
Harim	*Harrenc* / Harran / Harem
Ibelin	Yabna
Jacob's Ford	*Chastellet* / *Vadum Iacub* / al-'Atra / Metsad 'Ateret
al-Jundi	Sadr
Kerak	*Petra Deserti* / al-Karak
Latrun	*Toron de les Cabelleros* / *Toron des Chevaliers*
Le Destroit	Dustray
Li Vaux Moise	al-Wu'ayra
Maraclea	Maraqiyya
Margat	Marqab
Mirabel	Majdal Yaba

Mont Pelerin	*Mont Peregrinus* / Sangil / Tripoli
Montferrand	Barin / al-Bari'ah
Montfort	al-Qurain / *Starkenburg*
Montreal	Shawbak
Mount Tabor	Qal'at al-Tur
Ruad	Arwad
Rumkale	Qal'at al-Rum / Ranculat / Hromgla
Safed	*Saphet*
Saone	Sahyun / Qal'at Salah al-Din
Scandelion	Iskenderun
Sidon	*Sagette* / Saida
Sidon Land Castle	al-Mu'azza
Sidon Sea Castle	al-Bahr
Subayba	Nimrod
Turbessel	Tell Bashir
Toron	Tibnin
Tortosa	*Tortouse* / Tartus / Antartus
Trapessac	Darbsak

(*Frankish names have been italicised*)

Personal names have been spelled according to their most popular form in Western scholarship, i.e. 'Alexius Comnenus' is given in the Latin form whereas 'Niketas Choniates' is given in the Greek; similarly, 'Zanki' and 'Tughtakin' will be used rather than 'Zangi' and 'Tughtagin', while 'Qaraqush' will be used rather than 'Karakush'. European names have been anglicised where possible.

Medieval Weights and Measures[2]

dirham	Egypt	3.125 g
	Damascus	3.09 g
	Iran	3.2 g
ratl	Iraq	0.40625 kg
	Egypt	0.4375 kg
	fulfuli	0.450 kg
	kabir	0.500 kg
	laythi	0.620 kg
	jarwi	0.967 kg
	Damascus	1.85 kg
	Aleppo	2.27-2.28 kg
	Hama	2.062 kg
	Homs	2.7 kg
	Sahyzar	2.137 kg
	Tripoli	1.968 kg
	Palestine	2.2-2.5 kg
qintar	of gold	42.33 kg
	Egypt	43.75 kg
	Damascus	185 kg
	Aleppo	228 kg
	Hama	228 kg
	Rum (100 *lodra*)	56.44 kg
	Cyprus	226.4
oka	Cyprus	1.85 kg
cane	Cyprus	2.2 m
cubit	Egyptian/ordinary/*al-sauda'* (black)	0.5404 m
	al-yad (hand)	0.49875 m
	bi'l-najjari/al-mi'mariyyah (building/carpenter's)	0.789 m
	hashimi/al-'amal/al-malik (practical/royal)	0.665 m
	al-bazz (cloth) - Egypt	0.58187 m
	- Damascus	0.63035 m
	- Aleppo	0.679 m
	- Tripoli	0.64 m

[2] The Islamic measures are taken from Hinz, *Islamische Masse und Gewichte*, trans. Marcinkowski, *Measures and Weights in the Islamic World*. The Cypriot *qintar* has been taken from Coureas, *The Assizes of the Lusignan Kingdom of Cyprus*, p. 58 - my thanks to Peter Edbury for this reference. The Cypriot *oka* has been taken from Crawford, *The 'Templar of Tyre'*, p. 24 n. 4.

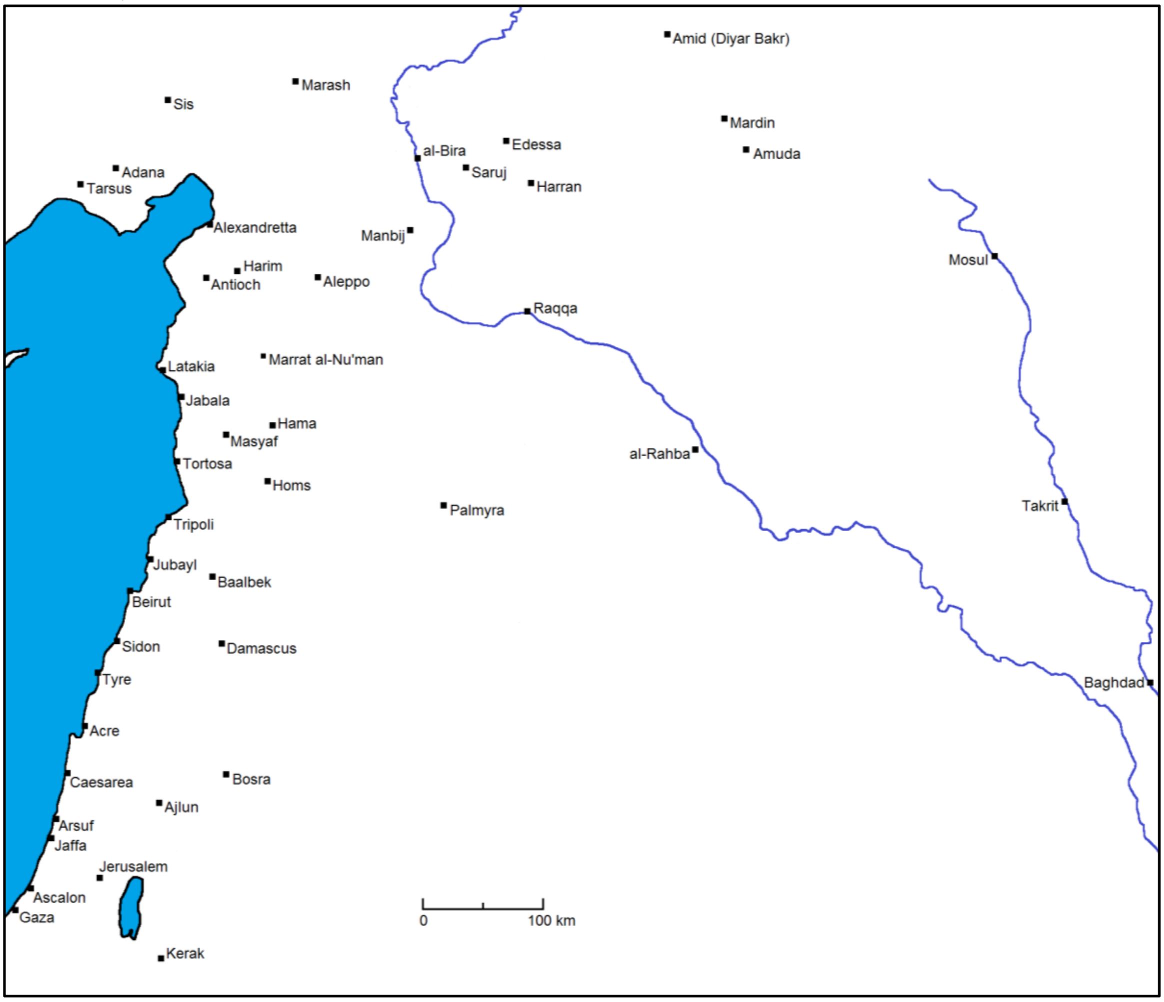
Acknowledgments

This project would not have been possible without the generous support of many people. Thanks are due to my colleagues at Queen's University, Canada, including Richard Greenfield, Fabio Colivicchi, Bernie Kavanagh and George Bevan, who all had a role in inspiring the early stages of this study. Long-time friend Ross Underhill, of the Royal Military College of Canada, was instrumental in refreshing my understanding of basic trigonometry and helping me set up the platform from which I have built my ballistic models. Mark Denny has been incredibly generous in running enumerable scenarios through his trebuchet algorithms, critically helping me establish the minimum mechanical dimensions of various hypothetical engines. Amr Bdour, Adrian Boas, Balázs Major, Jean Mesqui, Nicolas Faucherre, Kate Raphael, Rafi Lewis, David Nicolle, Letizia Boscardin and Donald LaRocca have all been very generous in passing along particular first-hand archaeological information while Peter Vemming Hansen and Renaud Beffeyte have kindly shared some of their experiences dealing with reconstructed trebuchets. Any mistakes or misinterpretations contained in this study, however, should be regarded as mine and mine alone.

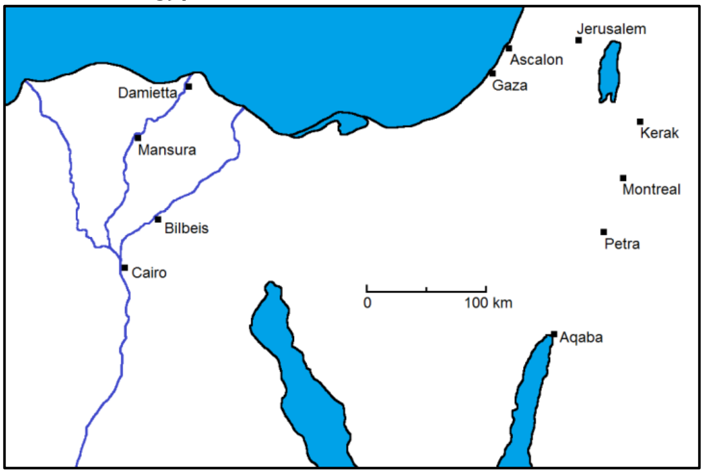
It has truly been a privilege to work with the world-leading scholars of the Latin East here at Cardiff University. I am deeply indebted to my supervisor, Denys Pringle, as well as Peter Edbury for the knowledge and skills that they have imparted on me. I am also grateful for the input provieded by my friend Rabei Khamisy; since our meeting at Montfort a few years ago, the extent of his help has stretched far beyond providing additional translations of critical Arabic passages.

Lastly, thanks are due to the women in my life: my mother, Elizabeth, who, among many other things, has been my frontline editor for more than a decade, and my fiancée Laura, who uprooted herself on a whim so that I could pursue my doctorate in Europe. The unwavering support of the former during my early studies and willingness of the latter to accommodate the inconveniences of my work in more recent years are what have allowed me to complete the following work.

Greater Syria



Northeast Egypt



Introduction

Siege artillery has interested historians for centuries. But while technical treatises, detailed descriptions and illustrations survive from the classical and Renaissance periods, evidence of artillery from the medieval period is more limited. In the absence of lucid contemporary descriptions, medieval artillery (mechanical stone-throwers) tends to be studied in a very broad context. Using anecdotal scenarios, often the most sensational, from wide geographic areas and across many centuries, historians have been able to put forward various theories regarding the development of artillery and what stage it had reached by certain points in the Middle Ages. Not surprisingly, such a broad approach has led to a fairly poor understanding of the nature of these engines, how they were tactically employed and the development of the mechanical system. In order to avoid the generalisations that have accompanied previous studies, the focus here will be on a specific region and a definite period of time: the Levant, from 1097 to 1291. To produce as complete a picture as possible, archaeological evidence will be examined alongside the textual evidence whenever possible.

Among the best studies of medieval siege warfare to examine this region and period, are those of Randal Rogers, Christopher Marshall and John France. While the first two deal with only half of this period, one study conducted by France is extremely specific and the other very broad. None of these, however, focuses on artillery.[3] Contrastingly, Paul Chevedden has examined medieval artillery closer than perhaps any other modern scholar. His theories, however, tend to be built around a selection of anecdotes, often at the expense of appropriate context, which has led to a skewed interpretation of the

[3] Rogers, *Latin Siege Warfare*; Marshall, *Warfare in the Latin East*; France, *Victory in the East*; France, *Western Warfare*. Rogers devotes the most attention to artillery; however, his primary concern is siege towers when dealing with Frankish sieges in the Levant during the twelfth century. He claims that the use of artillery was better suited to the Normans of South Italy and examines it in this context, despite its more frequent appearance in sources dealing with the Latin East.

development of these engines.[4] The present study is, in part, a response to the ideas of exaggerated power popularised by Chevedden. When all of the evidence is considered, mechanical artillery (trebuchets) do not appear to have developed into breaching engines before the late thirteenth century.

Many sieges were conducted in the Levant between 1097 and 1291 and individuals of various ethnicities have left records of these events. Before the contemporary evidence is addressed, Part One will establish certain basic premises. Chapter 1 will examine the development of artillery up to 1097, touching on various historiographical interpretations. Understanding the disparity of evidence and academic disagreement over the form and spread of artillery in the Early Middle Ages is critical because judgements relating to the use of artillery in this earlier period often influence interpretations of later engines. Chapter 2 will then outline the mechanical properties of a trebuchet. Only by understanding the mechanics can the source material be intelligently interpreted. To date, few studies have competently integrated a sound appreciation of mechanical physics with the contemporary accounts. This, perhaps more than anything else, has allowed certain misguided conclusions to come to be popularly accepted. Once these two basic components have been addressed, Part Two will examine the main body of source material.

This study will not be the first to examine the use of artillery during the crusades; however, it will be the first to examine all of the available evidence critically, dividing it into five parts. Chapter 3 will examine the First Crusade and establish a baseline by answering certain questions: What was Frankish artillery like at the end of the eleventh century? How powerful was it? How familiar was it to the various Frankish personalities who took part in the crusade and the Muslim defenders whom they encountered? Did either side possess a technological advantage? Chapter 4 will then examine how artillery was used during the twelfth century and how it developed during this period. Chapter 5 will cover the period between the Battle of Hattin (1187) and the end of the Third Crusade (1192). The number of sieges and wealth of sources demand that this five-year period be examined closely. It is around this time that counterweight trebuchets appear to have been developed and employed with increasing effect. Although no contemporary account

[4] See Chevedden, *The Citadel of Damascus*; Chevedden, "Artillery of King James I," pp. 47-94; Chevedden, "The Hybrid Trebuchet," pp. 179-222; Chevedden, "Fortifications and the Development of Defensive Planning," pp. 33-43; Chevedden, "Invention," pp. 71-116 ; Chevedden, "Black Camels," pp. 227-77; Chevedden, "King James I," pp. 313-39.

clearly proves that such engines were used at any particular siege, there are strong indications that they were. Moving forward, Chapter 6 will deal with the first half of the thirteenth century, in which new terms for identifying artillery appear, as does the first archaeological evidence. Terminology and physical evidence become vitally important in Chapter 7, which attempts to discern the strength and diversity of artillery in the second half of the thirteenth century. Stratigraphically datable projectiles provide sound material evidence while the Muslim sources increasingly classify the engines that they mention. Combining these elements allows one to make a reasonable estimation of the scale and power of certain machines. On some occasions, topographical conditions can be incorporated to render quite accurate ballistic models, revealing necessary energy minimums and thus a quantitative sense of power and scale, something that has never before been attempted in this field.

After all the evidence has been examined, Part Three will assess its broader significance. Taking account of the power, diversity and method of employment of artillery, Chapter 8 will address the influence that offensive engines had on the design of fortifications. Complementing this, Chapter 9 will assess the degree to which a desire to incorporate artillery as a defensive weapon may have influenced fortification design. Critically, the matter of whether or not certain large towers dating to the early thirteenth century were meant to resist or support the heaviest counterweight trebuchets of the day will be considered.

To conclude, a final assessment of the development and use of artillery will be offered. It is hoped that this study, in its entirety, will contribute to a sounder understanding of the trebuchets employed in and around the Latin East in the twelfth and thirteenth centuries.

PART ONE:

ORIGINS AND MECHANICS

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1. Artillery before the Crusades

At the end of the eleventh century, the stone-throwing artillery used by Western Europeans and most Byzantines and Arab armies appears to have been of the 'trebuchet' type. The torsion-powered engines of the classical era seem to have fallen from use sometime in the Early Middle Ages. These engines were replaced directly, or after a period of delay, by the simpler swing-beam or lever family of artillery broadly referred to today as trebuchets. The matter of when, or even if, torsion artillery was replaced by trebuchets is a contested one; however, the latter appear to be the engines used most commonly, if not exclusively, by Latin, Greek and Muslim forces on the eve of the First Crusade. Initially these were light traction engines, powered by the pulling force of a team of operators. At some point around the late twelfth century, these engines came to be supplemented by an increasingly heavy variety that was powered by a falling counterweight. Whereas the traction trebuchet remained a largely antipersonnel weapon, counterweight trebuchets were increasingly used to target the bulk of fortifications as they were built ever larger and more powerful through the thirteenth century.

Classical Artillery

The first stone-throwing engines used in Europe and the Near East appear to have been adapted from earlier arrow-shooting machines. Construction of the earliest of these arrow-shooters is generally attributed to Dionysius the Elder of Syracuse. Developed at the start of the fourth century BC, the *gastraphetes*, or *katapeltikon*/*katapeltes*, was a defensive weapon. It was little more than a composite bow mounted on a wooden stock and operated by a mechanised draw and release, quickly developed to incorporate a winch to increase the potential tension energy of the bow.[5] Even more energy could be drawn from the two-armed torsion bow, which dates from about the middle of the fourth century BC. Horizontal arms were inserted into vertically mounted coils of hair and sinew, and an arrow or bolt was placed in a grooved stock that extended backwards from between the two coils. The potential torsion energy stored in the coils was far greater than that in a tension bow of comparable size, allowing for stones to be used as projectiles as larger engines of this type were built.

Vitruvius (d. c.15 BC) divided torsion bows into two categories: bolt-throwing *catapultae* (or *scorpiones*) and stone-throwing *ballistae*.[6] Even at this early point, there are modern historians who rush to view early stone-throwing machines as breaching weapons.[7] Although Vitruvius provides figures for a machine capable of throwing a stone projectile in excess of 150 kg, he himself concedes that such an engine may never have been (previously) built. His figures are instead more of an exercise in demonstrating a supposed ideal proportional relationship between the various mechanical components and the corresponding size of the projectile they were intended to throw. As in the medieval period, it seems that most classical projectiles weighed no more than about 20 kg.[8]

Torsion bows were employed throughout the Roman period and were used by the Greek defenders of Massalia (Marseilles) during Caesar's Civil War in the first century BC and by both the attackers and defenders during Titus's siege of Jerusalem in the first century AD.[9] These weapons became such an intrinsic part of Roman poliorcetics that Frontinus (d. c. 103) deemed their development to have reached its peak long before his own time.[10] Centuries later, these same weapons are referred to in the works of Ammianus (d. c. 395) and Vegetius (fl. 4th century).[11] It is noteworthy that Roman historians mention

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[5] Marsden, *Historical Development*, pp. 48-85; Soedel and Foley, "Ancient Catapults," pp. 150-60; Chevedden, "Artillery in Late Antiquity," pp. 134-36; DeVries, *Medieval Military Technology*, pp. 127-29; Campbell, *Greek and Roman Artillery*, pp. 3-15; Campbell, "Ancient Catapults," pp. 678-82.
[6] For a full contemporary description, see Vitruvius, *De Architectura Libri Decem* 10.10-11, ed. F. Krohn, pp. 245-50, trans. Morgan, pp. 303-8.
[7] For example, Soedel and Foley, "Ancient Catapults," pp. 150-60; DeVries, *Medieval Military Technology*, pp. 128-29.
[8] For surveys of classical projectiles at various sites, see Campbell, *Greek and Roman Artillery*, pp. 19-22; Nossov, *Ancient and Medieval Siege Weapons*, pp. 137-42; Holley, "Ballista Balls," pp. 349-65; Syon and Yavor, "Gamla," pp. 40, 42-44; Adan-Bayewitz and Aviam, "Iotapata," pp. 131-65; Aviam, "The Archaeological Illumination," pp. 376-77; Wilkins, Barnard and Rose, "Roman Artillery Balls," pp. 66-80; Savage and Keller, "Archaeology in Jordan," p. 478.
[9] Caesar, *De bello civili* 2.1-2, ed. and trans. Peskett, pp. 124-27; Josephus, *The Jewish Wars* 5.6, trans. Whiston, pp. 810-11.
[10] Frontinus, *Strategmata* 3.preface, ed. McElwain and trans. Bennett, p. 204.
[11] Ammianus, *Res gestae* 23.4.1-3, ed. Eyssenhardt, p. 270, trans. Yonge, p. 322; Vegetius, *Epitoma rei militaris* 4.9, 22, ed. Lang, pp. 134-35, 143-44.

these engines more often in a defensive capacity than in an offensive one, although they clearly served both functions.

To complicate matters, a change occurred in the terminology used to describe the torsion bow around the fourth century AD. *Catapulta*, traditionally denoting an arrow-shooting machine, was generally replaced by *ballista*, formerly used to identify a stone-throwing type.[12] Ammianus clearly states that the torsion bow remained in use through the late imperial period, a point confirmed by archaeological evidence dated to the late fourth century.[13] Two-armed torsion catapults were used almost exclusively as bolt-throwers in Europe by the fifth century, although by this point metal tension bows may have come into use.[14] As arrow-firing engines developed into precision rather than power-based weapons, they were occasionally used by medieval forces, as the Romans did before them, to propel incendiary arrows.[15] It is important to acknowledge that through this cyclical course of development and transitioning use of terminology, it is often difficult to discern whether later medieval authors, who adopted these classical terms, intended them to refer to a bolt-throwing engine or one that threw stones.

The other type of torsion engine described by Vegetius is the *onager* or 'wild ass', so called on account of its kick. In the fourth century, this was the heaviest ballistic weapon in the Roman arsenal, used to target personnel as well as other engines.[16] This one-armed stone-thrower used the power of a single large horizontal coil, against which the perpendicularly extending throwing arm was drawn back. Upon release from its relatively horizontal loading position, the arm was abruptly stopped at a desired angle of release by a sturdy crossbeam, allowing the projectile, held in a cup at the end of the arm, to fly free along a desired parabolic path. Although not as accurate as the flat trajectory of two-armed torsion bows, the advantage of the one-armed engine was its power and

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[12] For interpretations of this shift in terminology, see Marsden, *Historical Development*, pp. 188-89; Marsden, *Technical Treatises*, pp. 25-51; Campbell, "Ancient Catapults," p. 690; Chevedden, "Artillery in Late Antiquity," pp. 137-42.

[13] For a brief summary of archaeological remains of Roman artillery, see Bishop and Coulston, *Roman Military Equipment*, pp. 58-61, 88-90, 168-70, 206-8; Baatz, "Recent Finds in Ancient Artillery," pp. 1-17.

[14] The tension-powered *arcuballista* was possibly the predecessor of the medieval siege crossbow or springald. Such an engine may have been used at the siege of Pairs in the eighth century, see Abbo, *Bella Parisiacae urbis*, ed. Pertz, pp. 9-10.

[15] This often involved fitting a metal basket filled with flaming material behind the tip of a bolt or simply heating the heads of standard bolts or arrows in a fire. Robert of Normandy used such to set fire to the roof shingles of Brionne, Orderic Vitalis, *Historiae ecclesiasticae* 8.13, ed. and trans. Chibnall, 4:4:208-11. Cf. Ammianus, *Res gestae* 23.4.14-15, ed. Eyssenhardt, p. 272, trans. Yonge, p. 324.

[16] Vegetius, *Epitoma rei militaris* 4.22, ed. Lang, pp. 143-44.

comparative simplicity.[17] These factors, as well as the decline of the administrative infrastructure and technical expertise, probably contributed to the decline of stone-throwing torsion bows under the Romans and the eventual abandonment of all torsion weapons in Western Europe sometime around the sixth century or perhaps the seventh.

The range of the *onager* was increased at some point during the Roman imperial period when a sling replaced the cup at the end of the arm. The sling effectively elongated the throwing arm, without adding any notable mass. This allowed the projectile to travel farther in the same amount of time before release, increasing acceleration and release velocity without retarding the angular velocity of the throwing arm or increasing the potential energy in the coil, which would have required the whole structure of the engine to be strengthened. Thus the whole system was made more efficient.

Torsion Artillery in the Early Middle Ages: Continuity or Replacement

Fundamental to the question of what type of artillery was employed by the earliest crusaders, is the debate concerning the extent to which torsion power remained in use through the Early and High Middle Ages and at what point, if any, it was replaced by a new type of engine unknown in classical Europe and the Middle East. At the root of the debate is the lack of clear source descriptions, illustrations or material evidence to support either the continued use of torsion engines or the emergence of a new type from about the end of the sixth century.

Certain classical texts that describe torsion engines are known to have survived and circulated during the High Middle Ages. For instance, Geoffrey Plantagenet appears to have had access to a copy of Vegetius at the siege of Montreuil-Bellay in 1147.[18] Although it is tempting to see him looking to the ancients for inspiration, there is little to suggest that he, or any of his contemporaries, ever constructed a torsion engine. At Montreuil-Bellay, Geoffrey's solution was the use of some kind of incendiary, which was thrown from what seems, from its description, to have been a traction trebuchet, a machine-type unknown to Vegetius and his contemporaries. When analysing the use of

[17] Two-armed catapults required constant adjustment to balance the resistance of the two spring coils.
[18] John of Marmoutier, *Historia Gaufredi ducis Normanorum*, ed. Halphen and Poupardin, pp. 215-19.

any siege engine, it is important to bear in mind the broader context: Geoffrey, like his predecessors a millennium before him, was a seasoned campaigner, familiar with poliorcetics and the construction of siege engines. If there is any truth in this story, it seems he was simply interested in exploring his options during what was evidently a difficult siege. Geoffrey's ingenuity is evident, as in addition to artillery, he is said to have used both towers and rams at this siege.

The survival of such classical texts, the use of unclear terminology by medieval sources and the reappearance of the *onager* in fifteenth-century illustrations have fuelled over two hundred years of debate concerning the medieval use of classical engines.[19] The primary issue is the lack of clear descriptions and the inconsistent use of terminology. Some scholars have chosen to avoid the linguistic issues and have found it sufficient to conclude that the barbarian societies that filled the power vacuum in the wake of the collapse of the Roman Empire were too simple to have supported the continued use of complex torsion weapons. Building upon this somewhat simplistic notion, certain others, notably Hill, Gillmor and Chevedden, have vigorously argued that a new form of artillery, the swing-beam type, or trebuchet, simply replaced the more complex torsion engines.

The Historiographical Debate

In the eighteenth century, Francis Grose concluded that the one-armed torsion engine was the dominant mechanical stone-thrower used during the medieval period until it was replaced by gunpowder weapons. He ambiguously grouped together an array of terms that he found in certain sources and was content to conclude that some threw darts and others stones, and that many threw both.[20] In the mid-nineteenth century, Colonel Guillaume Dufour concluded the opposite, arguing that the difficulties posed by procuring and arranging the sinews necessary for the coils of torsion engines made them an unattractive option. Instead, Dufour suggested that the simple counterweight trebuchet replaced the *onager* and the tension siege-crossbow replaced the torsion bow.[21] Matters took a step forward in 1850 when Louis-Napoleon Bonaparte had trials conducted with a reconstructed counterweight trebuchet built by Captain Favé at Vincennes. On the basis

[19] For summaries of the historiography, see Rogers, *Latin Siege Warfare*, Appendix 3, pp. 254-73; Chevedden, "Artillery in Late Antiquity," pp. 131-34.
[20] Grose, *Military Antiquities*, 1:380-84.
[21] Dufour, *Mémoire sur l'artillerie des anciens*, p. 97.

of his research, Louis-Napoleon also expressed the opinion that torsion machines were not used during the Middle Ages.[22]

At the start of the twentieth century, Sir Ralph Payne-Gallwey also favoured a replacement model. Payne-Gallwey believed that the loss of classical knowledge led to the rise of trebuchet technology: "If the knowledge of constructing the great [torsion] catapult of the ancients in its original perfection had been retained, such a clumsy engine as the medieval trebuchet would never have gained popularity." In his opinion, the range of torsion engines was so superior to that of the trebuchet that had they remained in use they would have considerably delayed the development of early cannon.[23]

Much of Payne-Gallwey's logic is flawed. Besides neglecting that certain classical texts circulated relatively widely in the Middle Ages, he approached issues of range by assuming that any engine must have been capable of outranging contemporary archers, placing this distance at 360-450 m. While Grose had concluded that torsion engines could not manage reported ranges of 5 stadia (about 900 m), even if firing from an elevated position, noting the frequency with which twelfth-century English castles were overlooked by hills only 400-500 yards (360-450 m) away, Payne-Gallwey accepted that a 25 kg projectile could be thrown over 2 stadia (about 360 m), as stated by Josephus (fl. c. 70 AD) or even 3½ stadia (about 630 m), as recorded by Athenaeus Mechanicus from the original work of Agesistratus (fl. c. 50 BC). By comparison, Payne-Gallwey judged it doubtful that a counterweight trebuchet, with a beam of 17 m, could ever have thrown stones over 90 kg to a distance of 315 m, the distance that he believed necessary for an engine to fire from to clear an opposing wall while remaining beyond the range of any archers on it.[24] Payne-Gallwey drew many of his conclusions from trials with small-scale models. Full-scale reconstructed replicas of torsion engines have proven less effective.

A century ago, Schramm's reconstructed *onager* managed to fire a small 1 lb projectile about 300 m.[25] In 2002, a much larger one-talent two-armed catapult, designed and made according to Vitruvius's specifications, which required 20,320 kg of oak and 4 km of rope, could not fire a 26 kg (about 1 talent) projectile more than 90 m.[26] The range of the latter engine is roughly the same as that of the smaller one-armed reconstructed

[22] Bonaparte, *Études sur le passé et l'avenir de l'artillerie*, 2:26-54.
[23] Payne-Gallwey, *A Summary of the History*, pp. 7-8.
[24] Payne-Gallwey, *A Summary of the History*, pp. 9-10, 27.
[25] Schramm, *Die antiken Geschütze der Saalburg*, pp. 29, 30.
[26] Purton, *Early Medieval Siege*, pp. 362-63; Campbell, *Greek and Roman Artillery*, p. 33.

catapult at Caerphilly Castle, which fires 3-4 kg projectiles.[27] In her recent analysis of torsion engines, Rihll advocates against underestimating the range of classical artillery and although she is weary of concluding that Josephus exaggerated the range of the Roman engines used at Jerusalem, she notes that the one-talent engine that he mentions was probably considered quite exceptional.[28]

By the end of the nineteenth century, the theories of replacement put forward by Dufour, Bonaparte and Payne-Gallwey had been challenged by Gustav Köhler, a Prussian general and artilleryman. Köhler contended that torsion-powered engines remained in use throughout the medieval period in Western Europe and were only challenged when counterweight trebuchets were introduced, at a date that he placed around 1200. The thirteenth century was then dominated by this new type of engine.[29] While many siege historians since Köhler have tended to reject the notion that torsion engines remained the standard, Köhler's dating of the emergence of the counterweight trebuchet has largely retained popular favour. Like many of those before him and since, Köhler attempted to support his theory by wading into the terminology slough. He interpreted *petraria* as a traction trebuchet, asserting it had Islamic origins and arrived in the West during the twelfth century. He believed that *mangana* referred to the one-armed torsion engine and *manganella* to a smaller two-armed rock-throwing torsion machine, rediscovered through the course of the First Crusade. The influential English historian, Sir Charles Oman, followed Köhler in large part, concluding that the siege equipment of medieval Europeans was of the same form as that of their Roman predecessors, the counterweight trebuchet being the only notable addition.[30]

Köhler's study left room for improvement and his theories were challenged by a line of scholars, led by Rudolf Schneider. In *Die Artillerie des Mittelalters* (1910), Schneider rejected the continuation argument primarily on the basis that the Latin sources of the medieval period are devoid of any descriptions of the essential component of torsion artillery: the coil of twisted sinews.[31] In this regard, Schneider returned to the model of Louis-Napoleon and Dufour, asserting that torsion-powered siege weapons fell from use with the collapse of the Roman Empire in the West. He went as far as to suggest

[27] Humphries, *Engines of War*, p. 4.
[28] Rihll, *The Catapult*, pp. 205, 228-31.
[29] Köhler, *Die Entwickelung des Kriegswesens*, 1:139-211.
[30] Oman, *A History of the Art of War*, p. 543, for his discussion of classical machines, pp. 131-49.
[31] Schneider, *Die Artillerie des Mittelalters*, pp. 1-60, esp. pp. 1-26.

that no artillery at all was used in Latin Europe during most of the Early Middle Ages, arguing that it only re-emerged at the end of the ninth century with the development of swing-beam engines. Schneider connected this technological jump with certain nautical traditions and nominated the Vikings as the inventors of the trebuchet, leaning heavily on accounts of the siege of Paris in the ninth century. From this point in history, he proposed that all of the various terms used to describe artillery referred to trebuchets. Although he postulated that certain terms corresponded with particular types, as his investigation was source-based, he recognised the complexity and possible futility of attempting to apply a firm terminological framework.

Source-based investigations were drastically widened by the Finnish scholar Kalervo Huuri, whose *Zur Geschichte des Mittelalterlichen Geschutzwesens* (1941) included Greek and Arabic sources along with the Latin. Huuri saw little evidence to support the continued use of the torsion bow in Latin Europe following the withdrawal of Roman influence but allowed for the continuation of the simpler one-armed catapult. The latter, he argued, remained in use through to the seventh century, when its employment became obscured in the terminology as the traction trebuchet came into use. Herein lies the real strength of Huuri's contribution: given his wider use of sources, he was able to identify the use of swing-beam technology outside Europe long before there is firm evidence of its use in the West. Huuri revealed that trebuchets were used in Asia centuries before the collapse of the Roman Empire and that the technology appeared to migrate westward, permeating Byzantine and Arab societies by the seventh century and the Eastern Mediterranean by the eighth. Counterweight propulsion, however, was not to make its appearance until the twelfth century and did not make a real impact until the thirteenth.[32]

Huuri offered an uneasy framework for the Latin terminology. By trying to balance the continued use of torsion catapults with the integration of swing-beam trebuchets, he came up with a classification system, almost arbitrarily defining *mangonella* as an engine that threw projectiles up to 5 kg while *petrariae* and *mangana* threw projectiles of 50-70 kg. He judged the heavier engines to be trebuchets while the weaker machines could have been light traction trebuchets or one-armed torsion catapults.

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[32] Huuri, *Zur Geschichte des Mittelalterlichen Geschutzwesens*, pp. 51-65, 212-17. See also Chevedden, "The Hybrid Trebuchet," p. 179.

A third, heavier, category was added with the development of the counterweight trebuchet.[33]

As a broader understanding of trebuchet dynamics developed during the later decades of the twentieth century so too could a better mechanical appreciation be injected into the debate. Randal Rogers has since criticised Huuri's judgement that swing-beam artillery was easily constructed and transported; although true of lighter engines, this is hardly the case when dealing with the heavy and long beams required by counterweight engines.[34] While Schneider appreciated the benefits of the simple light traction trebuchet,[35] this simplicity appears to have discouraged Latin forces in the Near East from prefabricating artillery through much of the twelfth century as the burdensome tasks of moving and storing such could be avoided if even moderately sized local timber was available.[36]

More than any other document, Abbo's account of the ninth-century siege of Paris has become a battleground for scholars arguing for and against the existence of swing-beam and torsion technology in Europe prior to the crusade period. Abbo repeatedly mentions various siege engines, including *catapultae*, *mangana* and *ballistae*, but at no point does he clearly describe them, thus allowing for various interpretations.[37] Paul Chevedden has emerged as the predominant champion of those presently arguing for the existence of trebuchet technology in Europe throughout most of the Early Middle Ages. Building on Huuri's approach, he has attempted to take into consideration as many sources as possible to trace the westward migration of the trebuchet. Chevedden argues that these engines had replaced classical torsion engines around the eastern Mediterranean by the sixth century and had been adopted in Northern Europe by the ninth.[38]

Some, arguing against this view, have rallied around the work of the late Lynn White Jr. White supported the argument for the absence of torsion engines during the Dark Ages but downplayed the significance of trebuchet technology.[39] To be fair, White dedicated little attention to poliorcetics and was clearly not an expert; however, the degree to which his arguments have been included in the subsequent historiography warrants his

[33] Huuri, *Zur Geschichte des Mittelalterlichen Geschutzwesens*, pp. 57-65.
[34] Rogers, *Latin Siege Warfare*, Appendix 3, pp. 269-70.
[35] Schneider, *Die Artillerie des Mittelalters*, pp. 50-60.
[36] See Fulton, "Development of Prefabricated Artillery," pp. 51-72.
[37] Abbo, *Bella Parisiacae urbis*, ed. Pertz, pp. 6-46.
[38] Chevedden, "Invention," pp. 73-74; Chevedden, "King James I," pp. 315-16.
[39] White, *Medieval Technology*, pp. 101-3; White, "The Crusades," pp. 97-112.

inclusion here. More recently, Jim Bradbury has taken up the argument of continuity, a sentiment supported in previous decades by D. J. Cathcart King.[40] Resurrecting Köhler's position, Bradbury suggests that Roman-style torsion engines remained in use throughout the Middle Ages.[41] Despite the arguments of his predecessors, Bradbury maintains that there is little to suggest that torsion engines were not used throughout the Middle Ages, although he concedes that 'mangonel' might have referred to a type of trebuchet by the twelfth century.

Following a path similar to that of Bradbury, Christopher Marshall, admittedly influenced by Oman, also supports a continuation model, believing that both the 'petrary' and 'mangonel' were torsion weapons.[42] Bernard Bachrach sidesteps the issue of continuity by highlighting the endurance and superiority of Roman military science. He argues that even if particular components of military technology changed through the Early Middle Ages, the institutions and methodologies of the Romans remained.[43] His son, David Bachrach, has directly argued that torsion engines remained in use, ignoring essentially all evidence except thirteenth-century English administrative documents.[44]

Many who support the idea of the continued use of torsion weapons do so as part of broader arguments relating to the continuity of classical technologies and scientific knowledge, fundamentally refuting any supposition that the Early Middle Ages were a period of decline in Europe. Ironically, those championing the replacement model also tend to refute any notion that this was a period of backwardness, focusing on the continuation of trade links and other cross-cultural interactions that could have introduced Asian swing-beam technology into Europe before the infamous siege of Paris. As many scholars suggest that counterweight trebuchets were used during the Third Crusade, this debate has drawn the attention of many historians of the crusades.

In his culturally thematic study of twelfth-century siege warfare, Randal Rogers highlighted certain technological and methodological approaches that he argued were favoured by various ethnic groups around the Mediterranean.[45] Although he provides an

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[40] King, "The Trebuchet," p. 459.
[41] Bradbury, *The Medieval Siege*, pp. 253, 259. The more obvious root is the Latin *petra* (stone), similar to the more frequently appearing *petraria*, see Fulton, "The Diffusion of Artillery Terminology."
[42] Marshall, *Warfare in the Latin East*, p. 213.
[43] B. Bachrach, "Medieval Siege Warfare," pp. 119-33.
[44] D. Bachrach, "English Artillery," pp. 1,408-30. See also Bachrach, *Warfare*, pp. 160-64.
[45] Rogers, *Latin Siege Warfare*. Rogers associates artillery predominantly with the Hauteville Normans of southern Italy, whose fluid and mobile style of warfare he sees as suited to the use of artillery. The sources, however, do not appear to emphasise the use of artillery in southern Italy any more than in contemporary Outremer and expose how his approach may be criticised for oversimplifying matters and stereotyping

excellent historiographical summary of the debate in an appendix and appears to favour the replacement side, he largely avoids the issue in the body of his work. Hugh Kennedy has taken a position in favour of Chevedden and Huuri, rejecting Marshall's assertion that torsion engines were used by or against Latin forces in the Near East.[46] John France has approached the issue with a more self-assured and considerably pragmatic attitude, given the relatively limited discussion that he dedicates to artillery. Acknowledging the founding contributions of Donald Hill and Carroll Gillmor, France argues that although the principles of torsion power were likely not forgotten, the flexibility, manoeuvrability and general pound-for-pound superiority of swing-beam engines made them preferable. He concludes that it was traction trebuchets that were used during the First Crusade.[47] France suggests that the wide array of terminology probably reflected the variety of artillery sizes and he is content to postulate, like Huuri, that *petraria* and *mangana* may have referred to larger machines while *mangonella* and *tormentum* denoted smaller ones.

The best arguments for the continued use of torsion artillery in Europe after the sixth century are the continued use of classical terms and the lack of conclusive evidence that they were not used; but neither of these arguments is particularly strong. Such engines were less powerful, more complicated, and far more dangerous to operate than swing-beam engines, given the pent-up stresses within the coil and then violent stop of the arm against a component of the framework when fired. Traction trebuchets, by comparison, were capable of a much higher rate of fire and were far simpler to construct, use and maintain. Heavier counterweight models, although larger in scale, are still simplistic in principle, requiring more labour rather than skill to construct. For present purposes, it will be assumed that all stone-throwers were of the swing-beam type during the period of the crusades, which the sources suggest was a near certainty. The mathematical representations of power that are included, however, are just as appropriate to torsion engines as to swing-beam engines.

Whether favouring a continuation or replacement model of torsion power, all historians tend to agree that trebuchets were the dominant form of artillery in Europe and

various cultures, paying insufficient attention to the unique context of each siege. See Amatus of Montecassino, *Ystoire de li Normant*; William of Apulia, *Gesta Roberti Wiscardi*; Geoffrey of Malaterra, *De rebus gestis Rogerii*; Alexander of Telese, *Ystoria Rogerii regis*; Hugo Falcandus, *Liber de regno Sicilie*.

[46] Kennedy, *Crusader Castles*, p. 107.

[47] France, *Western Warfare*, p. 119.

the Near East by the twelfth century. But when and where were they first used by European and Arab-Turkish armies?

Terminological Issues

The most significant issue confronting anyone attempting to discern whether the stone-throwing engines of the Early Middle Ages were classical torsion engines or newer swing-beam engines is the terminology used by contemporary sources. This is the same issue that confronts any effort to identify when trebuchet technology arrived in the West. To obscure matters further, very few European or Muslim illustrations of medieval artillery survive from before the twelfth century.[48]

Most references and descriptions of pre-fourteenth-century artillery are found in the chronicles, annals and letters of churchmen who, in most case, had little if any expertise in siege warfare and the diverse pool of terminology appears to reflect this. Until the term 'trebuchet' and its variants appear near the end of the twelfth century, most vocabulary used to identify siege machines was drawn from ancient sources. Rather than providing an accurate description of a siege or precise details of a piece of equipment, many authors appear to have used stock terms derived from classical sources. This may have been done to convey a sense of imagery to an audience that would probably have been familiar with the same classical texts, as part of an attempt to present their work in a classical style to give it greater authority, or simply out of ignorance of 'correct' terminology employed by those who operated such machines.[49] The terms *funda*, *catapulta*, *manganum* and *balista* are all found in Abbo's account of the siege of Paris, while *tormentum*, another classical term, as well as *petraria*, which first appears in the Early Middle Ages, were also used widely in the centuries leading up to the First Crusade and through the twelfth century. Matters can be further complicated when a single term is used to identify a machine that appears to take on a combined nature, such as a siege

[48] For medieval illustrations of artillery, see Appendix 1.
[49] My thanks to Denys Pringle for some of these ideas.

tower that incorporates a ram or some kind of ballistic machine.[50] In this way the lack of consistent nomenclature expands beyond artillery.

In some instances, such as Rahewin's account of Emperor Frederick I's wars, not only terminology but also writing style was heavily influenced by Greek and Latin authors, such as Vegetius, Josephus and Sallust.[51] This use of classical terms to describe medieval machinery makes any attempt by modern historians to provide vocabulary guidelines or date technological advancements extremely challenging, if not impossible. This, however, has not stopped some from trying. Much as Grose, Köhler and Huuri had, Cathcart King and others since have attempted to propose strict terminological guidelines.[52] The vague and inconsistent descriptions found in various Latin and vernacular European sources before the thirteenth century are sufficient to expose the pointlessness of such efforts.

Shifts in vocabulary and their meanings are known to have occurred. *Catapultae* and *tormenta* appear less frequently from the ninth century, while *petrariae*, *mangana* and *mangonella* are found more often. This, however, does not necessarily imply that there was a technological change at this point. *Manganon*, used by Greek authors from the fourth century, gradually permeated into Arabic as *manjaniq* and Latin as *manganum*.[53] During the Early Middle Ages, Arabic sources seem to have use *manjaniq* and *'arrada* interchangeably to describe the same type of ballistic machine, most likely a traction trebuchet. Like their Latin counterparts, most Arabic sources were content to mention the presence of one or more engines without providing a description or many details. Hill has suggested that the term *manjaniq*, which occurs more often, was a general one applied to the artillery of Arab forces,[54] similar to the way that *manganum* appears to have been used interchangeably with *petraria* in Latin Europe.

Chevedden disputes that such terms were often used as synonyms. In a Byzantine context, he has argued that *manganon* and *manganikon* were used to identify pole-framed trebuchets by some authors and as broader terms for trebuchets by others. He suggests that the *lambdarea*, or *labdarea*, was a trebuchet with a *lambda*-shaped trestle frame

[50] One such example is the Norman siege tower used at Brevol, Orderic Vitalis, *Historiae ecclesiasticae* 8.24, ed. and trans. Chibnall, 4:288-91. See also France, *Western Warfare*, p. 118.
[51] For example, Otto of Freising and Rahewin, *Gesta Friderici I* 4.46, ed. Waitz, pp. 285-87, trans. Mierow, pp. 278-79. See also Rogers, *Latin Siege Warfare*, pp. 127-28; Fino, "Machines de jet médiévales," p. 25.
[52] King, "The Trebuchet," pp. 461-62.
[53] Gillmor, "The Introduction of the Traction Trebuchet," p. 7; Bradbury, *The Medieval Siege*, p. 253. This is contrary to the belief held by A. W. Lawrence noted above.
[54] Hill, "Trebuchets," p. 100.

while *helepolis*, *petrobolos*, *petrarea* and *sphendone* were all used to refer to trebuchets with triangular-shaped trestle frames. Chevedden concludes that Anna Comnena thus identifies separate machine types when noting the use of *petrobolos* and smaller *lithobolos* in the twelfth century, equating these with trestle and pole varieties of trebuchet respectively.[55] In an Arabic context, he equates *'arrada* with the simple pole trebuchet and *manjaniq* with those with a trestle framework,[56] which seems probable by the end of the eleventh century.

Neither the search for etymological roots nor the picking and choosing of terms, which the sources fail to demonstrate were consistently applied to singular mechanical forms, are an adequate basis upon which to establish a terminological typology. Latin sources frequently equate various terms and existing terms were almost certainly reapplied to new technological developments. For example, Otto of Freising mentions a stone-throwing *balista*, which he also calls a *manga*, during his account of the siege of Tortona in 1155.[57] Although classical *balistae* were arrow-shooters, such engines are again described as stone-throwing machines during the siege of Ascalon in 1153.[58] It is hard to identify any intended difference between the *mangana* and *predeirae* in Caffaro's account of the siege of Almeria in 1146 or the *petraria* and *mangonella* in Roger of Wendover's account of the siege of Lincoln in 1217.[59] However, this does not rule out the likelihood that certain sources intended to draw distinctions between certain terms, only that this was not done uniformly. William of Tyre identifies the artillery at the siege of Jerusalem in 1099 as *mangana* and *petrariae*, grouping them as if synonyms, but later notes that *mangana* threw smaller stones than certain other engines, which he does not identify.[60]

Like *manganum*, the Latin term *petraria* also has Greek roots. First appearing in seventh-century Byzantine sources, *petrarea* appears to have become synonymous with *manganon* by the late ninth century. Gillmor has suggested that the term could then have infiltrated Latin from the eighth century through Frankish interaction with the Greeks of

[55] Chevedden, "Invention," p. 79.
[56] Chevedden, "King James I," pp 321-22.
[57] Otto of Freising, *Gesta Friderici I* 2.21, ed. Waitz, p. 124, trans. Mierow, p 135.
[58] *Auctarium Aquicinense*, ed. Bethmann, p. 396. See also *Auctarium Affligemense*, ed. Bethmann, pp. 401-2.
[59] Caffaro, *Annales*, ed. Belgrano, 1:34-35, trans. Hall and Phillips, pp. 69-70; Roger of Wendover, *Flores Historiarum*, ed. Hewlett, 2:214-15, trans. Giles, 2:393-94.
[60] *machinas iaculatorias, quas mangana et petrarias vocant*, William of Tyre, *Chronicon* 8.6, 13, ed. Huygens, 1:392-93, 403, trans. Babcock and Krey, 1:350-51, 362.

Italy.[61] Paul the Deacon, writing in the eighth century, records the Byzantines' use of a siege engine, which he claims was commonly called a *petraria*, to throw the head of a certain Lombard leader over the walls of a besieged city in 663.[62] If those favouring theories of replacement are correct, *petraria* may have referred exclusively to swing-beam engines in a Latin context. Regardless, *petraria* (literally 'stone thrower') became the most common term used to specify artillery in Latin sources by the end of the twelfth century.

While the use of more specific vocabulary became more common with time, ambiguous terms appear at least as frequently up to and throughout much of the twelfth century. Whereas William of Tyre mentions *machinae* at one point in his account of the siege of Jerusalem in 1099, the *Eracles* translation replaces this with the terms *perriers* and *mangoniaux*.[63] Roger of Wendover calls these same engines *petrariae* and *trebuculi*, the latter being a term that would not have been understood by those taking part in the siege.[64] While terminological specificity may help clarify the use of later artillery, it remains unclear at what point swing-beam artillery was first used in Europe and the Near East. Although many cultural interactions have been put forward as the possible catalyst for this westward transference, there is little solid evidence to attribute credit to any of them.

The Early Use of Traction Trebuchets in the West

The traction trebuchet appears to have been developed in Asia centuries before the first of such engines were employed in Europe. Links between swing-beam artillery technology and China were drawn in the mid-nineteenth century by Louis-Napoleon, and have since been developed by scholars such as Huuri, Needham and Yates.[65] In his assessment of these Chinese engines, Donald Hill estimated that a typical beam, whether

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[61] Gillmor, "The Introduction of the Traction Trebuchet," pp. 7-8.
[62] Paul the Deacon, *Historia Langobardum* 5.8, ed. Waitz, p. 189, trans. Foulke, p. 221.
[63] For example, William of Tyre, *Chronicon* 8.6, ed. Huygens, 1:392-93, cf. *Eracles* 8.6, RHC Oc 1, p. 563.
[64] Roger of Wendover, *Flores Historiarum*, ed. Coxe, 2:137-38, trans. Giles, 1:430.
[65] Bonaparte, *Études sur le passé et l'avenir de l'artillerie*, 2:35; Huuri, *Zur Geschichte des Mittelalterlichen Geschutzwesens*, pp. 56-65, 212-27; Needham, "China's Trebuchets," pp. 107-45; Yates, "Siege Engines," pp. 414-19; Needham and Yates, *Science and Civilization in China*, pp. 203-40.

consisting of a single mass or several spars lashed together, was between 5.6 m and 8.4 m long, tapering from a diameter of 12.5 cm to 7 cm at the tip of the long arm, suggesting that light engines had a beam ratio of 5:1 or 6:1 and heavier engines about 2:1 or 3:1. The ammunition, Hill suggested, was probably 1-60 kg and was fired 75-120 m.[66] These Chinese machines appear to have been developed between the third and fifth centuries BC. By the seventh century AD, there is evidence that engines of this type had infiltrated the Arab world and illustrative evidence places them in Turkmenistan by the eighth century.[67] By the ninth century, they may have been employed in Western Europe.[68]

At its simplest, this type of weapon was little more than a vertical forked pole with another, fitted with a sling, laid across it, using the fork as a fulcrum point.[69] Although relatively light, it could throw heavier projectiles than a staff sling to greater distances, while still manned by a single operator. These 'pole trebuchets' could easily yaw around their y-axis and their minimalist structure allowed them to be moved with relative ease, making them the most flexible type of trebuchet. This light engine was an antipersonnel weapon but it is when the single supporting pole is replaced by a trestle frame and manned by a team of men that some scholars rush to suggest that it was intended to damage masonry.[70] Evidence from Asia confirms that traction trebuchets had reached a complete level of development centuries before the technology arrived in the West. Although there are sensationalised accounts of extremely large and destructive traction trebuchets, these appear to have remained quite light. Ahead of the First Crusade, the traction trebuchet was clearly embraced by Latin, Greek and Muslim armies, but when and through whom the technology was transmitted from Asia remains unclear.

The Greek World

The Byzantines are most commonly nominated as the first to use swing-beam artillery technology in the environs of the Mediterranean, but it is an account of the siege of Thessalonica by the Avaro-Slavs in the late sixth century that is often proposed as the earliest definitive description of the use of traction trebuchets in Europe.[71] According to

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[66] Hill, "Trebuchets," p. 102.
[67] See **Fig. B1**.
[68] Gillmor, "Introduction of the Traction Trebuchet," p. 1; Chevedden, "Invention," p. 74; Chevedden, "King James I," pp. 315-16.
[69] See **Fig. B2**.
[70] For example, Gillmor, "Introduction of the Traction Trebuchet," p. 4.
[71] For the defences of Thessalonica, see A. W. Lawrence, "A Skeletal History of Byzantine Fortification," p. 185.

the first-hand account found in the *Miracles of St Demetrius*, the besiegers spent the first and second days of the siege constructing stone-throwers, as well as rams and a shelter for mining. The artillery was ready on the third day and was then used to throw stones until the siege was lifted on the seventh day, the rams and mining efforts having been thwarted by the defenders.[72]

The *ballistrae* of the Avaro-Slavs are described as tetragonal, the frames tapering as they rose. To these were affixed beams, clad in iron at their ends, and to them were fashioned very long framing timbers. Slings were hung at the back ends of these beams and ropes from the front, which when pulled, released the sling and propelled the stone couched within into the air with a loud noise. The framework was covered on its three exposed sides with boards to protect those firing them within from arrows, indicating they were within range of the city's archers.[73] Apart from the 'loud noise' at release,[74] all factors suggest that these were traction trebuchets. As for their size, when the protective panelling of one of the engines was set alight by a flaming arrow, the machine was simply carried away by its operators, repaired and then carried back into place to resume firing the following day. To be moved with such ease again suggests that these were light machines of an antipersonnel scale.

The source, however, claims that the garrison hung cloth curtains and mattresses in front of their battlements to lessen the impact of the Slavic artillery and that a large section of wall was destroyed by these engines. While this suggests that these were quite powerful machines, this may not have been the case. The practice of padding battlements against the ballistic engines of besieging armies was not unique. This had precedent in classical sieges and was subsequently undertaken by the defenders of Mayet in 1098, against William II, by the defenders of Jerusalem in 1099, during the First Crusade, and by those defending Mesoten in 1219, when besieged by the Teutonic Order.[75] At Thessalonica, the padding is described as only cloth hung from thin rods, suggesting that this was not a significant barrier. Furthermore, the author's assertions that fifty engines

[72] *Miracles of St Demetrius*, ed. Lemerle, pp. 148-54.
[73] *Miracles of St Demetrius*, ed. Lemerle, p. 154. While Vryonis argues for a literal reading of this description, Lemerle suggests otherwise in his edition, *Miracles of St Demetrius*, ed. Lemerle, p. 154 n. 65; Vryonis, "The Evolution of Slavic Society," p. 384 n. 23.
[74] Cf. Seneca, *Qaestiones naturales* 2.16, ed. Monfrè, p. 558; trans. Clarke, p. 67. *Nam balistae quoque et scorpiones tela cum sono expellunt*. See also Marsden, *Historical Development*, p. 97.
[75] Orderic Vitalis, *Historiae ecclesiasticae* 10.10, ed. and trans. Chibnall, 5:258-59; Ralph of Caen 124-25, RHC Oc 3, pp. 692-93, trans. Bachrach and Bachrach, pp, 140-42; Albert of Aachen 6.17.19, pp. 424-29; Fulcher of Chartres 1.27.8, ed. Hagenmeyer, pp. 297-98, trans. Ryan, pp. 120-21; Henry of Livonia, *Chronicon* 23.8, ed. Prutz, pp. 156-57, trans. Brundage, p. 181.

were arrayed against the eastern wall, that they were constructed within two days, and that they threw 'mountains' are incongruent. Even with modern equipment, to build a machine of this type with dimensions sufficient to threaten classical walls would take a number of days; to compound this by fifty is unimaginable even if the whole army were skilled craftsmen. The destruction that is noted appears to have been added to illuminate the perceived 'mountainous' size of the projectiles that were thrown: an emotive expression of the experience rather than an accurate description of the reality. By comparison, it is unlikely that early modern siege guns could not have breached these impressive walls in so short a period. While much has been made of this account and its significance, all of these observations rely on the accuracy of a single source.[76]

Speros Vryonis Jr. has concluded, primarily on the basis of Procopius's descriptions, that the Slavs were lightly armed fighters who lacked siege equipment and until the mid-sixth century took towns by ruse or escalade.[77] Vryonis places the Slavs' first use of siege equipment in 587 at the siege of Appiareia in Moesia Inferior. According to the account of Theophylact Simocatta, a captured Byzantine soldier betrayed the methods of building a ballistic siege engine, a *helepolis*, to the Avars: in a single day, the Slavs jumped from constructing ladders to building machines able to reduce cities.[78] For this theory to work, however, Vryonis must contend that the siege of Thessalonica took place in 597 rather than in 586.[79]

To base the entire technological ability of an ethnicity and its near instantaneous diffusion upon the instruction of a captured soldier is to stretch credulity. The mechanics of a swing-beam engine are so straightforward that merely seeing the beam pivot on its axis, noting the presence of a sling and its rough proportions, is enough for anyone with any kind of carpentry background to build something of this type. This simplicity allows crews to become quickly familiar with the firing process and designers to adjust the sling length to achieve a desired range through nothing more than a brief period of trial and

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[76] Although he appears to have been an eyewitness, the author may have written out his account decades after the events that he witnessed, Purton, *Early Medieval Siege*, pp. 29-32.
[77] Vryonis, p. 385-87. At no point does Procopius ever explicitly declare that the Slavs lacked siege equipment. Vryonis's presumption is based entirely on this omission.
[78] Theophylact Simocatta, *History* 2.16.1-11, trans. Whitby and Whitby, pp. 65-66.
[79] The siege is reported to have been carried out on a Sunday, 22 September, during the reign of Maurice, leaving only 586 and 597 as candidates. For the broader context and likelihood of the latter date, see P. Yannopoulos, "La pénétration Slave à Argos," pp. 339, 359, 364.

error.[80] The machines built at Thessalonica seem to reflect this tradition rather than a secret weapon bequeathed by a traitor. Furthermore, there is little to suggest that the *helepolis* was a ballistic engine; the term was more often used by Greek sources to denote a siege tower. The story seems little more than a racially motivated explanation of how a supposedly 'barbaric' people were able to replicate and incorporate a piece of 'civilised' technology, comparable to Henry of Livonia's similar explanation of how the Estonians acquired trebuchet technology in the early thirteenth century.[81]

While it appears possible that the Avars were responsible for importing this technology from Asia, it seems more likely that it had reached the Byzantines ahead of their arrival. If the episode of acute betrayal is set aside, it would appear that the Avaro-Slavs acquired their knowledge of the trebuchet from the Byzantines. Tracy Rihll has even expressed scepticism towards the theory that Byzantine trebuchet technology originated in Asia, suggesting it may have been developed from the staff sling.[82] Although known in the Greek world since at least the seventh century, the traction trebuchet appears to have remained a fairly light weapon, used in a supporting role, over the following centuries.[83]

Eric McGeer has analysed the siege weapons available to the Byzantines between the tenth and eleventh centuries on the basis of four surviving texts.[84] His work highlights the pre-eminent use of mining and even siege towers rather than artillery, which was generally employed in a defensive context or grouped with the assailing archers and slingers in a supportive position. McGeer concludes that despite the wealth of theoretical works on siege warfare, technologically and tactically it was a fairly simple art, especially concerning artillery. Attrition, guile and tunnelling were the most popular Byzantine siege techniques.[85] The chroniclers seem to confirm this.

While most descriptions of artillery present it as a light supportive weapon, the accounts of Tughrul's siege of Byzantine Manzikert in 1054 suggest the use of a much

[80] This is quite unlike the Byzantine monopoly of the recipe for Greek fire, which required particular materials and proportions unrecognizsable when utilised. Similar, if less effective, naphtha-based incendiaries were widely used.
[81] See Fulton, "The Diffusion of Artillery Terminology."
[82] Rihll, *The Catapult*, pp. 263-64, esp. n. 71.
[83] It is predominantly historians of Western Europe who have credited the Byzantines with developing trebuchet technology once it reached the Mediterranean. Cf. A. W. Lawrence, "A Skeletal History of Byzantine Fortification," p. 222 and n. 137.
[84] McGeer, "Byzantine Siege Warfare," pp. 123-29. The sources are Hero of Byzantium, the anonymous *De obsidione toleranda*, the *Taktika* of Nikephoros Ouranos and the *Strategikon* of Kekavmenos. The first two are from the classical *poliorketika* tradition, the latter two were composed by contemporary soldiers.
[85] McGeer, "Byzantine Siege Warfare," p. 129.

more powerful engine. Aristakes Lastivertc'i describes how the attackers' initial catapult was counteracted by a defensive counterpart that would shoot the stones of the Turkish engine out of the sky. In response, the assailants prepared another engine, a *baban*, that required four hundred men to pull certain ropes and threw stones weighing 60 *litrs* (about 20 kg) from its sling. From a position fortified against the defenders' artillery with cotton loads, the *baban* opened a breach with its first shot, although it was later burnt in a ruse by the Byzantines.[86] In his slightly later account, Matthew of Edessa emphasises that the attackers focused on mining; it was only after the garrison had successfully countermined that Tughrul brought up a large engine, said to have been built by Emperor Basil. Matthew claims that this engine weighed 15 *adil* (about 3,400 kg) and inflicted a number of casualties among the town's sentinels. In this account, the engine was temporarily put out of action by a defensive machine, before it was burnt in a sally.[87]

In his assessment of this siege, Paul Chevedden assumes that this engine was a traction trebuchet. Although this is probable, Chevedden takes the figure of four hundred pullers at face value. This leads him to disregard Aristakes' measure when assessing the supposed mass of the engine's projectiles and adopt the Syrian *ratl* instead, rendering a mass of 111 kg.[88] Chevedden appears to exaggerate the scale of the engine in this way so that it fits into his linear theory of trebuchet development, this machine representing a supposed 'hybrid trebuchet'.[89] When considering Matthew of Edessa's account, written about ninety years after these events, it is unclear how he acquired his figure of the engine's weight, or how such a value would be determined accurately. But whereas Aristakes clearly presents this as a breaching engine, Matthew describes it as being directed against the defenders along the parapet and not at the mass of the wall. When taken together, both authors agree that a notable stone-thrower was used by the Turks and that the defenders also made use of artillery. This event actually appears to support McGeer's theory that artillery, while known to the Byzantines, was generally used as a supportive weapon, hence why the presence of a large assailing engine is notable and why the defensive stone-thrower is even portrayed as something of a novelty.

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86 Aristakes Lastivertc'i, *Patmut'iwn*, trans. Bedrosian, pp. 100-5.
87 Mathew of Edessa, *Patmowt'iwn* 2.3, trans. Dostourian, pp. 86-88 (p. 87 n. 5 for the weight conversion).
88 Chevedden, "King James I," pp. 323-24, esp. p. 324 n. 43; Chevedden also allows for Huuri's suggestion that the intended measurement was 600 *litrs*, Huuri, *Zur Geschichte des Mittelalterlichen Geschutzwesens*, p. 170.
89 For this stage of Chevedden's theory, see Chevedden, "The Hybrid Trebuchet," pp. 179-222, for the engine employed by Tughrul at Manzikert, see pp. 187-88, 203.

The Muslim World

As swing-beam technology appears to have been present in the Balkans by the end of sixth century, so too are there indications that it had reached the fringes of the Arab world by this time or shortly thereafter. In 630, a *manjaniq* is said to have been used when Muhammad besieged the town of Ta'if,[90] but there is little evidence that the Arabs employed any advanced siege equipment during their conquest of Byzantine Palestine and Syria in the first half of the seventh century. The tactics employed at the sieges of Damascus, Homs, Tikrit and Mosul seem to have been restricted to guile and blockade, staples of Muslim siege warfare throughout the centuries to come. Artillery was used to bombard Persian Ctesiphon; however, these engines seem to have been constructed by Persian deserters.[91] The Arabs' ability to launch a fleet and deploy artillery at the siege of Lapathos (Lapta) in 648, suggests that by this point certain Muslim armies possessed the technology to build and operate their own siege machines. The link between artillery and naval technology appears evident by the presence of artillery on board the ships from Alexandria that attacked Chalcedon in 653,[92] two centuries before the Vikings' siege of Paris. Artillery was used by both the Muslim defenders and Byzantine attackers during the siege of Chandax (Heraklion) by Nicephoras Phocas in 960-61.[93]

Like the story about the Slavs at Appiareia, the Syriac Maronite Chronicle relates how a master carpenter from Paphlagonia offered to build 'Abd al-Rahman ibn Khalid a stone-thrower at the siege of Synnada (Suhut) in about 664.[94] The engine seems to have been a traction trebuchet, but in this case the story serves to illustrate the disparity in expertise and experience between the Arabs and the Byzantines. After the Arabs had fired three shots that failed to reach the walls, the defenders let fly a shot from their own defensive engine that smashed the Arabs' machine to pieces. This suggests that by the third quarter of the seventh century this technology was known in at least parts of the Arab world but that it may still have been quite new and not fully appreciated.

The *manjaniq* described by al-Tabari at the siege of Mecca in 683 appears to have been a traction trebuchet, while a similar engine appears to have been used at the siege of Daybul in Sind in 708 – supposedly operated by a crew of five hundred men and a single

[90] Hill has judged this to be a classical torsion weapon, Hill, "Trebuchets," p. 100. Setting terminology aside, it seems slightly more likely that this was an early swing-beam machine.
[91] Purton, *Early Medieval Siege*, pp. 37-41.
[92] Sebeos, *History* 36, trans. Bedrosian, pp. 169-70; Purton, *Early Medieval Siege*, p. 47.
[93] Michael Attaleiates, *History* 28.4.6, ed. and trans. Kaldellis and Krallis, pp. 410-17.
[94] Purton, *Early Medieval Siege*, p. 47.

skilled operator. Hill has suggested that the increasing frequency with which descriptions of swing-beam engines are found in accounts of the Arabs' eastern campaigns is indicative of an exchange of knowledge that occurred in central Asia during the Umayyad offensive from 660 and that all earlier mentions of artillery refer to torsion engines.[95] Despite its increasing use, artillery rarely had a direct influence on the outcome of Eastern sieges in the Early Middle Ages; successfully concluded sieges were most often the product of blockade or escalade, while most breaches were opened though mining. When viewed more broadly, frontier warfare tended to be light and mobile as the Muslim world rapidly expanded during the Umayyad period and the use of light traction trebuchets seems to reflect this.

The Frankish World[96]

The apparent use of trebuchets by the Slavs in the Balkans, a Byzantine presence in Italy and Arab incursions across the Pyrenees from Iberia, provide three possible routes by which trebuchet technology could have been introduced to Western Europe. Carroll Gillmor has suggested that the exchange might have happened in Muslim Spain and spread to Aquitaine in the ninth century while Peter Purton has suggested that this exposure might have resulted from the Muslim siege of Toulouse in the eighth century.[97] Although Gillmor notes that it was during the ninth century that there was a noticeable shift in terminology and the *manganum* was incorporated into the Carolingian siege arsenal, according to the *Vita Hludowici*, the notion that Charlemagne and Louis the Pius travelled with a siege train on occasion is not direct evidence that they employed swing-beam engines.[98]

The south of France hosted many of Europe's most significant eighth-century sieges; but successful or otherwise, there is very little evidence for the actual use of artillery by the Carolingians. Although simple engines employed during the classical period were used, notably the ram, it is possible that the Carolingians ruled over a domain where the heavy bow was the most powerful ballistic weapon, supporting Schneider's theory of an era in Europe devoid of siege artillery. As there seems to be evidence that

[95] Hill, "Trebuchets," pp. 100-3.
[96] Throughout this study, the term 'Frank' will be used broadly to designate Latin Europeans throughout this study.
[97] Gillmor, "Introduction of the Traction Trebuchet," pp. 6-8; Purton, *Early Medieval Siege*, pp. 57-59.
[98] Gillmor, "The Introduction of the Traction Trebuchet," pp. 6-7. The ease with which traction trebuchets can be constructed exposes this to question if nothing else.

the Visigoths were employing swing-beam technology by this time, Purton similarly suggests that this might reflect a period between the torsion catapult's fall from use and the introduction of swing-beam artillery from Iberia or southern Italy.[99] Like the Arabs, the late Merovingians and Carolingians appear to have found the blockade to be their most effective siege tactic; however, the limited sources available and their rare description of sieges cast a degree of doubt on any interpretation.

During the relative stability that accompanied the peaceful years of Carolingian rule, the enthusiastic clergy often took advantage of the readily available supply of stone tied up in civic defences to build new cathedrals. Unknowingly, this exposed their flocks to new dangers in the ninth century with the onset of Viking raids up many of Europe's rivers. Although the sources remain extremely poor for the most part, the Vikings are noted as employing some form of artillery in certain instances. Reciprocally, Charles the Bald is recorded to have used "new and sought out types of machines" against a Norse army pinned in Angers in 873.[100] It is tempting to jump to the conclusion that this indicates the use of a new type of stone-thrower; however, this is the extent of the description and the machines could just as easily have been a new type of ram or even a siege tower. Casting caution aside, historians such as Ferdinand Lot have argued that this represents the first definitive use of swing-beam artillery in Europe, in no small part influenced by references to the presence of Byzantine engineers, indicating the source of this new technology.[101] This obscure but enticing reference gains further significance when considered in the context of the siege of Paris twelve years later.

Abbo's eyewitness account of the siege of Paris in 885-86 provides a small moment of clarity amidst the narrative fog of the Early Middle Ages. In the autumn of 885, a composite Viking force laid siege to Frankish Paris, which controlled access along the Seine.[102] Although this is a rare example of a detailed siege account during this period, the degree to which it has been used as evidence for both the continued use of classical

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99 Purton, *Early Medieval Siege*, pp. 66-68. Purton concludes that torsion siege weapons likely fell from use during the Merovingian period and that if trebuchet technology was known in the West, the Franks seem to have lacked the skill to employ it.

100 *Igitur ex omnibus partibus urbe obsidione circumdata, multis diebus undique summa virtute dimicatur, nova et exquisita machinamentorum genera applicantur; sed conatus regis prosperitatis effectum non optinuit, quia et loci facies non facilem prebebat accessum et paganorum valida manus, quia pro vita res erat, summo resistebat conamine*. Regino of Prum, *Chronicon*, ed. Kurze, p. 106. Cf. *Annals of St Bertin and St Vaast*, ed. Dehaisnes, p. 235.

101 Lot, *L'Art Militaire*, pp. 221-22.

102 Abbo, *Bella Parisiaca urbis*, ed. Pertz, pp. 6-46. Cf. *Annals of St Bertin and St Vaast*, ed. Dehaisnes, pp. 322-27.

torsion artillery and its replacement is entirely unjustified. While Oman claimed that the arsenal of Vegetius was clearly employed by the Vikings, having acquired this technology through a half-century of raiding against the Franks, Schneider saw sufficient evidence to conclude that the Vikings had invented swing-beam artillery, fostered by their nautical tradition.[103] Like Schneider, Gillmor regards the use of the term *mangana* as indicative of a new type of engine, but also suggests that torsion engines were used, associating these with the *catapultae* because of their supposedly slower rate of fire.[104]

Such arguments hinge primarily on one paragraph of text. Abbo relates,

> Our men prepared heavy beams each with an iron tooth at its end, so as to damage the machines of the Danes more quickly. With upright frames of the same length they built what are commonly called *mangana*, from which they threw vast stones, which could crush the low race of savages.[105]

Although Abbo claims that such stones could crush men and shields, this is far from conclusive evidence that the machines in question were either torsion or swing-beam engines. The iron prong affixed to the end of the throwing arm strongly suggests that this was used to hold a sling, a feature of both types of engine. At one point during the early winter, Abbo claims that the defensive engines in the city were used to support the bridgehead tower on the north bank of the river; however, he later describes this as being beyond their effective range following the tower's capture. Such inconsistencies, along with the absence of a clear description of either the structure of a stone-throwing machine or its firing process, and the single mention of the term *mangana*, compared to six mentions of *catapulta* and two of *balista*, unfortunately allow for no definite conclusions regarding the form of these engines.[106]

Following the siege of Paris the muted nature of the sources resumes and references are rare through the tenth century and into the eleventh. Little more can be discerned regarding the nature of swing-beam technology in Europe up to the departure

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[103] Oman, *A History of the Art of War*, pp. 141-48; Schneider, *Die Artillerie des Mittelalters*, pp. 53-54, 60-61.

[104] Gillmor, "The Introduction of the Traction Trebuchet," p. 5.

[105] This author's translation, *Magno cum pondere nostri / Tigna parant, quorum calibis dens summa peragrat, / Machina qup citius Danum Quisset terebrari; / Conficiunt longis aeque lingis geminatis / Mangana quae proprio vulgi libitu vocitantur, / Saxa quibus iaciunt ingentia, seo iaculando / Allidunt humiles scaenas gentis truculentae*. Abbo, *Bella Parisiacae urbis* 1 ll. 360-66, ed. Pertz, p. 18.

[106] For variants of *catapulta*, see Abbo, *Bella Parisiacae urbis* 1 ll. 157, 236, 535, 2 ll. 238, 252, 385, ed. Pertz, pp. 11, 14, 23, 34, 35, 39, for *ballista*, 1 l. 87, 2 l. 242, ed. Pertz, pp. 9, 34.

of the First Crusade.[107] There is little evidence to suggest that stone-throwing torsion engines were employed beyond the sixth century and such engines had few advantages to support their continued use following the introduction of the traction trebuchet. While relying on isolated events in particular sources, like the sieges of Thessalonica and Paris, is hardly a good historical practice, in most cases they are the only bits of evidence available. Suffice it to say that when the sources become more numerous and more detailed at the end of the eleventh century, the lack of any evidence to support the use of torsion artillery by Latin armies implies that this type of artillery had fallen from popular use prior to this. Likewise, the emergence of conclusive evidence for the use of traction trebuchets, described in terms which give no indication that this is a new type of machine, strongly suggests that these machines had already been in use for some time previously.

Most twelfth-century descriptions of artillery continue to depict these engines as antipersonnel weapons. For example, the *balistae*, which Otto of Freising claims were now called *mangae*, used by Frederick Barbarossa at Tortona in 1155 appear to have been used to clear the besieged battlements of defenders, similar to Matthew of Edessa's description of the Turkish engine at Manzikert.[108] In the second half of the century, suggestions of a new type of engine begin to appear. The first shot loosed by William the Lion of Scotland's *periere* at Wark in 1174 was discharged early and flew backwards hitting a Scottish knight.[109] A similar event took place in 1206 when a Russian engine misfired at the siege of Holm.[110] These accidents seem to imply that the form of the machines that were used were not new but that the physics of the firing process were still somewhat unappreciated by the engine's operators: the slings were probably of an incorrect length or the projectiles fell out of their couched position before being lifted off the ground. While these events may simply speak to the inexperience of the operators, the nature of these accidents is more suited to a counterweight trebuchet than a traction variety. At Wark the victim is described as being unscathed and at Holm the Russians are described as wounded rather than killed, suggesting that the responsible engines were not large. While such instances hint at the development of the counterweight trebuchet, they are far from conclusive evidence. Ammianus describes a similar accident in which a

[107] For example, Peter Vemming Hansen has dated the arrival of swing-beam artillery in Denmark no earlier than 1134, Vemming Hansen, "Experimental Reconstruction," p. 189; Vemming Hansen, "Witch with Ropes for Hair," p. 15.
[108] Otto of Freising, *Gesta Friderici I* 2.21, ed. Waitz, p. 124, trans. Mierow, p. 135.
[109] Jordan Fantosme, *Chronique* ll. 1,245-55, ed. and trans. Hewlett, pp. 306-8.
[110] Henry of Livonia, *Chronicon Lyvoniae* 3 (10.12), ed. Arndt, p. 37, trans. Brundage, p. 63.

Roman soldier was killed when a torsion engine misfired at the Roman siege of Maogamalcha (in Mesopotamia) in 363.[111]

The Emergence of the Counterweight Trebuchet

The counterweight trebuchet appears to have been developed during the period of the crusades. The earliest known surviving illustration of a counterweight trebuchet is that drawn by al-Tarsusi around 1180,[112] arguably predating any clear textual description of such an engine. Although this is strong evidence that this type of technology was known, and likely employed, in the Near East before the Third Crusade, there is little consensus among scholars as to when and where the counterweight trebuchet was first developed. Using al-Tarsusi's illustration as a reference point, most scholars assume that counterweight artillery was developed in the mid- to late twelfth century, most likely somewhere around the Mediterranean. By the early thirteenth century there is strong evidence that such engines were being employed across Western Europe and by 1218 *trabuculi* are noted at the crusaders' siege of Damietta.[113]

Origin of the Counterweight Trebuchet

There are numerous theories as to where and when the counterweight trebuchet was first invented. Most place the inception of this engine-type in the twelfth century though opinions vary on where it was first used geographically. For example, Randal Rogers has suggested that the increasing professionalism of the experts employed by Roger II of Sicily and his successors might have contributed to the development of the counterweight power system in south Italy, though he does not rule out the possibility that counterweight trebuchets might also have developed in the realm of Islam. Wherever the counterweight trebuchet was first invented, Rogers suggests that a powerful incentive for its

[111] Ammianus, *Res gestae* 24.4.28, ed. Eyssenhardt, p. 308, trans. Yonge, p. 362.
[112] See **Fig. C1**. For a discussion of this illustration and its accompanying description, see Appendix 1.
[113] See Chapter 6. See also, Oliver of Paderborn, *Historia Damiatina* 12, 38, 39, ed. Hoogewed, pp. 181, 237-38, 239, trans. Gavigan, pp. 64, 94, 96; Roger of Wendover, *Flores Historiarum*, ed. Hewlett, 2:229, 243, 250, trans. Giles, 2:406-7, 418, 424-25.

development was the consolidation and expansion of monarchical powers during the twelfth century and the military rivalry that this produced.[114]

According to some scholars, the earliest description of a counterweight trebuchet can be found in Niketas Choniates' account of the Byzantine siege of Zegminon in 1165.[115] Andronicus Comnenus is said to have employed engines (*petrobolous mekhanas*) that threw stones weighing a *talent*. Each made use of a sling (*sphendone*), winch (*strophalos*) and screw press (or beam) (*lugos*) and, in conjunction with mining, were able to cause the opposing fortifications to begin to crumble.[116] Niketas seems to describe Andronicus's use of a similar engine at the siege of Nicaea in 1184.[117] Rather than the apparent power of these engines, it is the winch, a component not found on a traction trebuchet, that has drawn scholarly attention. It is possible that Niketas is leaning on classical sources and his description reflects earlier descriptions of torsion-powered engines; however, it seems at least as likely that he is describing a counterweight trebuchet. As he was writing somewhat after these events, it is also possible that the descriptions provided by Niketas more accurately reflect Byzantine artillery used at the very end of the twelfth century or start of the thirteenth. According to Paul Chevedden, however, the origins of the counterweight trebuchet are to be found earlier than this, though still with the Byzantines.

Prior to the development of the counterweight trebuchet, Chevedden argues that there was a 'hybrid' model of traction trebuchet, which dates back as far as the ninth-century siege of Paris.[118] According to Chevedden, it was Emperor Alexius Comnenus who invented the counterweight trebuchet, postulating that Alexius's eastward campaigns against the Seljuks might have been the impetus for this supposed development. The first of these new engines were then provided for the crusaders to use at Nicaea in 1097.[119] This theory, however, rests entirely on the account of events given by the emperor's daughter decades later.

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[114] Rogers, *Latin Siege Warfare*, pp. 247-48.
[115] Niketas Choniates, *Historia*, trans. Magoulias, p. 76. For suggestions that this is the earliest evidence of the use of a counterweight trebuchet, see, for example, DeVries, *Medieval Military Technology*, p. 138 and Kennedy, *Crusader Castes*, p. 107. See also Chevedden, "Invention," pp. 86-87.
[116] For the Greek terms, see Chevedden, "Invention," pp. 86-87.
[117] Niketas Choniates, *Historia*, trans. Magoulias, p. 156.
[118] Chevedden, "The Hybrid Trebuchet," pp. 196-98; Chevedden, "Invention," p. 99.
[119] Chevedden, "Invention," pp. 86-87; Chevedden, "King James I," p. 316. Cf. Anna Comnena, *Alexiad* 11.2.1, trans. Sewter, pp. 335-36. The context of this description bears resemblance to the engines supposedly invented by Alfred of England in the ninth century, Florence of Worcester, *Chronicon ex chronicis*, ed. Thorpe, 1:89, trans. Forester, p. 66.

Many have hypothesised that counterweight artillery was used at Tyre in 1124.[120] Using William of Tyre's later account of events, Chevedden has suggested that Havedic, the Armenian summoned by the Franks to improve their artillery, brought the Byzantine knowledge of counterweight technology, which had been developed less than thirty years earlier by Emperor Alexius, with him to Tyre.[121] Ronnie Ellenblum has rejected Chevedden's theory that counterweight engines were first used at Nicaea, citing a lack of evidence to support this, but using William of Tyre's account alone and focusing on the presence of Havedic, asserts that a counterweight trebuchet was used at Tyre in 1124.[122] Chevedden has since refuted Ellenblum's criticism and defended his theory that the origin of the counterweight trebuchet is to be found in 1097.[123] Searching in other directions, some scholars have looked to the Islamic world for the origins of the counterweight trebuchet.

David Nicolle favours a theory that counterweight artillery developed under Islam during the tenth century and has suggested that the presence of wall-mounted artillery at the Byzantine siege of Tarsus in 965 might be the earliest reference to such.[124] But like Chevedden to an extent, Nicolle's interpretations fall victim to over-literal readings of certain sources at times, unquestioningly accepting Usama's description of millstones being thrown against Shayzar in 1138 for example.[125] Like discerning when or whether torsion stone-throwers fell from use during the Middle Ages and when traction trebuchets came into use in certain areas, terminology offers little to pin down exactly when the first counterweight trebuchets were used.

Frankish Terminology

In Europe, the first surviving variants of the term 'trebuchet' date to the late twelfth century. *Trabuchellus* is found alongside *manganum* and *prederia* in an agreement of fealty made in Vicenza on 6 April 1189.[126] A decade later, *trabucha* can be found alongside *predariae* at the siege of Castelnuovo Bocca d'Adda in the account of Iohannes

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[120] For a more detailed discussion, see Chapter 4.
[121] Chevedden, "Invention," p. 92. Cf. William of Tyre, *Chronicon* 13.10, ed. Huygens, 1:597-98, trans. Babcock and Krey, 2:15-16.
[122] Ellenblum, *Crusader Castles*, pp. 193-94, 208-10.
[123] Chevedden, "King James I," p. 317 and n. 9.
[124] Nicolle, "Early Trebuchet," p. 270.
[125] Nicolle, "Early Trebuchet," pp. 270-72.
[126] *Nec cum mangano, nec Trabuchello, aut cum Prederia, vel Balista vel Archu traham, nec aliquem trahere permittam, nec faciam, si vetare potero usque ad finem sue consularie*, in Verci, *Storia degli Ecelini*, no. 52, 3:97.

Codagnellus.[127] Despite the eagerness of some scholars to view this as clear evidence of the presence of counterweight trebuchets in northern Italy, John France has astutely pointed out that Codagnellus does not describe the engine that he identifies with this term and even seems to indicate that they are fairly light in subsequent references.[128] Cathcart King even discarded this reference in his study of trebuchets because it is listed along with other machines in an effort to secure a ditch.[129]

The origin of the term trebuchet is not clear. King has suggested that it comes from *trebucher*, to rock or tilt,[130] while William Sayers has provided a more thorough etymological study.[131] The variety of forms that this term takes in the early thirteenth century, including *trabocco*, *tribok*, *tribuclietta*, *trubechetum*, and numerous other vernacular renderings, appear to obscure any certainty.[132]

From about the late 1210s, variations of 'trebuchet' appear more frequently in the sources and seem to identify more definitely counterweight trebuchets. In the *Chanson de la Croisade Albigeoise*, Simon de Montfort's northern crusaders as well as the defenders of Toulouse are said to have employed *trabuquetz* and there are indications that these engines were exceptional. A French trebuchet apparently required only one shot to smash a tower of Castelnaudary and one more to destroy its great hall in 1211.[133] The power of the Toulousians' trebuchets is also emphasised during their preparations and defence of the city in 1217-19:

> Inside Toulouse so many carpenters were busy building strong fast-firing double trebuchets that no tower or hall, rampart or merlon was left undamaged in the Narbonnais castle confronting them.[134]

However, other engines are also characterised in this way: Simon de Montfort's *calabres* and *peirers* are credited with breaching one of the towers and granted the crusaders

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[127] Iohannes Codagnellus, *Annales Placentini*, ed. Pertz, p. 420, ed. Holder-Egger, p. 25. See also France, *Western Warfare*, pp. 121-23; Huuri, *Zur Geschichte des Mittelalterlichen Geschutzwesens*, p. 171.
[128] France, *Western Warfare*, p. 122, p. 273 n. 33.
[129] King, "The Trebuchet," p. 461.
[130] King, "The Trebuchet," p. 461.
[131] Sayers, "The Name of the Siege Engine *trebuchet*," pp. 189-96.
[132] For more on the appearance of these terms, see Huuri, *Zur Geschichte des Mittelalterlichen Geschutzwesens*, pp. 63-64.
[133] *Chanson de la croisade Albigeoise* 92, ed. Meyer, 1:93-94, trans. Shirley, pp. 51.
[134] *E lains en Toloza ac aitans carpentiers* / *Que fan trabuquetz dobles e firens e marvers,* / *Qu'el castel Narbones que lor es frontaliers* / *No i remas tor ni sala, dentelh ni murs entiers*, *Chanson de la croisade Albigeoise* 192, ed. Meyer, 1:285, trans. Shirley, p. 141.

temporary access to Toulouse.[135] Rather than the notion of increased power, it is the mention of certain technicalities that suggest something new. In one instance it is recorded that "more than ten thousand tallied on the ropes" of these engines as they assailed the Narbonnais castle,[136] possibly suggesting that these were traction engines, but soon afterwards the defenders "ran to the ropes and wound the trebuchets",[137] suggesting the winching back of the main beam of a counterweight trebuchet. The latter appears to be the more accurate reading, as to fire the engine the defenders "then released their ropes."[138] Although there are few indications that these engines were significantly stronger than the traction trebuchets next to them, they appear to have been quite accurate. Their slings were loaded with well-dressed stones, which on one occasion destroyed an assailing penthouse.[139] Worthy of note also are Bernard Parayre and Master Garnier, two men whose task it was to "manage the trebuchets as they were accustomed to this work".[140] The presence of these apparent experts is significant, but so too is the limit of their charge, which appears not to have extended to the *calabres*, *engenhs* and *peirers* that are mentioned only one line above. While references to "fast-firing double trebuchets" are enough to leave doubts as to how much we can read into this episode, the terminology clearly took root. In 1226, the defenders of Avignon are noted to have made use of *trabucheta* as well as *petrarie*, and *mangonella*.[141]

The earliest surviving use of the term trebuchet in British context accompanies Prince Louis' invasion of England and his siege of Dover in 1216-17. According to the *Historia des Ducs de Normandie*, Louis brought and set up a *trebuket* against the castle.[142] Richard of Morins similarly notes the use of a *tribuclietta* along with many other engines.[143] Although Roger of Wendover does not give an account of the second portion of the siege of Dover, during which the other sources use the new term, he may be referring to the same engine when he claims that Louis summoned a particular *petraria*

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[135] *Chanson de la croisade Albigeoise* 198, ed. Meyer, 1:311-13, trans. Shirley, pp. 156-57.
[136] *Chanson de la croisade Albigeoise* 198, ed. Meyer, 1:310, trans. Shirley, p. 155.
[137] *Chanson de la croisade Albigeoise* 203, ed. Meyer, 1:332, trans. Shirley, p. 167.
[138] *Chanson de la croisade Albigeoise* 204, ed. Meyer, 1:333, trans. Shirley, p. 168.
[139] *Chanson de la croisade Albigeoise* 204, ed. Meyer, 1:333, trans. Shirley, p. 168.
[140] *Chanson de la croisade Albigeoise* 213, ed. Meyer, 1:377, trans. Shirley, p. 191, see also 198, ed. 1:310, trans. p. 155.
[141] *Chronico Sancti Martini Turonensi*, ed. Holder-Egger, p. 73.
[142] *Histoire des ducs de Normandie et des rois d'Angleterre*, ed. Michel, pp. 188, 192-96.
[143] Richard of Morins, *Annales Prioratus de Dunstaplia*, ed. Luard, pp. 48-49.

before beginning the siege in 1216.[144] Although Roger uses the term *trebuculus* to identify engines at the sieges of Jerusalem in 1099 and Damietta in 1218, he at no point uses this term in a European context, notably omitting it during his discussion of the Albigensian Crusade.[145]

German sources also begin to employ this new terminology at this time. Otto IV is reported to have used a *tribok*, or *tribracho*, in 1212 against Weissensee.[146] Henry of Livonia, writing in the Baltic region in the 1220s, does not employ any new terminology but it is possible that he used *machinae maiores*, distinguished from the *patherelli* and *machinae minores*, to identify counterweight trebuchets.[147]

The relatively sudden appearance of this new terminology does not rule out the likelihood that counterweight artillery was employed in Europe before large contingents of crusaders began arriving in the Levant in 1189. Likewise, the earliest appearances of these new terms is not enough to allow one to state conclusively that they were used exclusively to refer to counterweight trebuchets. After returning home from the Third Crusade, Philip II Augustus may have used counterweight trebuchets at Verneuil in 1194[148] and Château Gaillard in 1203-4,[149] though the sources do not use any new terminology to identify these engines. Similarly, the prefabricated engines that Richard I made use of at Nottingham in 1194 might also have been counterweight trebuchets identified by traditional terminology.[150] While this might suggest that the new technology was acquired in Palestine, the analysis in Chapter 5 will suggest that the artillery

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144 Roger of Wendover, *Flores Historiarum*, ed. Hewlett, 2:191, trans. Giles, 2:374-75. See also Matthew Paris, *Chronica maiora*, ed. Luard, 2:664. Ralph of Coggeshall, *chronicon Anglicanum*, ed. Stevenson, p. 185.

145 Roger of Wendover, *Flores Historiarum*, ed. Coxe, 2:135, ed. Hewlett, 2:229, trans. Giles, 1:429, 2:406-7, cf. ed. Hewlett, 2:252, 310, trans. Giles, 2:426, 478-79.

146 *Et inde progrediens, obsedit oppidum Wizense, quod similiter expugnavit usque ad arcem. Ibi tunc primum cepit haberi usus instrumenti bellici, quod vulgo tribok appelleri solet*. *Annales Marbacenses*, ed. Wilmans, p. 172. *Movens igitur castra contra miniciunculam in Salcza tribracho illo, cognomento tribock, muris inminet*. *Cronica Reinhardsbrunnensis*, ed. Holder-Egger, p. 580. *Tribracho* is given in the *Chronica S Petri Erfordensis*, ed. Holder-Egger, p. 383. See also Schneider, *Die Artillerie des Mittelalters*, p. 28.

147 One such engine was prepared during the winter of 1216-17 while another was used at the siege of Mesoten in 1220 and another at the siege of Waldia in 1226, Henry of Livonia, *Chronicon Lyvoniae* 4 (21.5, 23.8, 30.5), ed. Arndt, pp. 138, 156-57, 220, trans. Brundage, pp. 164, 180-81, 243. The notable German engine at Fellin in 1211, apparently distinct from the *machina minor*, which is equated here with *patherellus*, may also have been a counterweight trebuchet, Henry of Livonia, *Chronicon Lyvoniae* 4 (15.1), ed. Arndt, pp. 79-80, trans. Brundage, p. 106.

148 Roger of Wendover, *Flores Historiarum*, ed. Hewlett, 2:123, trans. Giles, 2:135; Ralph of Diceto, *Ymagines histriarum*, ed. Stubbs, pp. 114-15.

149 William the Breton, *Philippide* 7, ed. Delaborde, pp. 201-4; William the Breton, *Gesta Philippi Augusti* 128-129, ed. Delaborde, pp. 218-19.

150 Roger of Howden, *Chronica*, ed. Stubbs, 3:238-40, trans. Riley, 2:314-16; *Pipe Roll 40 (1194)*, ed. Stenton, p. 43.

technology of all parties, both Christian and Muslim, was relatively similar. While even the largest counterweight trebuchets appear to have been quite small at this time, increasingly large and more powerful engines were built as time went on.

The term *bricola* and similar terms, including *biblieta*, *biffa*, *blithe* and *blida*, first appears in the early to mid-thirteenth century. The engine most associated with the term *bricola* appears to have been the pole-framed variety of counterweight trebuchet; a single vertical support carried the main axle and two counterweights were hung from the forked short arm.[151] Terms like *bricola* are rarely mentioned in the context of the crusades and no vivid descriptions exist of the use of such an engine in the Levant.[152] References to such engines are limited to little more than Frederick II's dispatch of *bricolae*, along with *prederiae* and *machinae,* to the Holy Land in 1242 and mention of a *biblieta* in the *Excidium* at the siege of Acre in 1291.[153] Unlike variants of *trebuchetum*, which appear relatively frequently in the thirteenth-century Frankish sources, these other terms, and perhaps the engines with which they were most commonly associated, were not widely embraced.

Muslim Terminology

In the early thirteenth century, Muslim sources also began to use a series of new Arabic terms to classify various types of trebuchets. These terms, including mangonels of the *shaytani*, *qarabugha*, *maghribi* and *ifranji* types, do not correspond with the earlier labels provided by al-Tarsusi in the late twelfth century. According to al-Tarsusi, the 'Frankish' mangonel was a light traction trebuchet; however, the same term was used by later sources to identify the heaviest type of contemporary artillery – some kind of counterweight trebuchet. While these later terms are helpful when determining what types of trebuchets were used at certain sieges, as will be examined below, they are of limited help when trying to identify when the first counterweight trebuchets came into use.

Having examined the Arabic terminology used before the appearance of these new terms, Chevedden has argued that augmenting adjectives such as *kabir* (big), *'azim*

[151] See **Fig. G9**, and **Figs. F18-F20**, **F24**, **F26** and **F29**. See also Appendix 1.
[152] Etymologically, Chevedden has interpreted *bricola* to come from the Latin *bi-coleus* ('double testicle') in reference to its design, Chevedden, "Invention," p. 109. David Nicolle has suggested that the term simply refers to the divided 'arms' of the short arm of the beam, while the variant *biblieta* might similarly refer to the division or opening of the short arm like a book, Nicolle, "The Vocabulary of Medieval Warfare," p. 173.
[153] Caffaro, *Annales*, ed. Cesare Imperiale, 3:128.

(great), and *ha'il* (frightful or huge) were used to specify moments of technological change.[154] Arguing in favour of three stages of development – the traction trebuchet, the hybrid trebuchet and the counterweight trebuchet – this allows him to categorise any engine described with such terms from the sixth century through the thirteenth as he sees fit. Accordingly, he views any instance where these adjectives were added from the twelfth century onwards as indicating the presence of counterweight trebuchets, such as at the sieges of Baghdad (1157), Alexandria (1174), Masyaf (1176), and Kerak (1184).[155] Although possible, this line of thinking appears to be overly convenient and lacks supporting evidence. As will be shown, it appears probable that counterweight trebuchets were coming into use by the late twelfth century; however, there is little solid evidence to support their use at any particular siege before the start of the thirteenth century.

Considerable uncertainty remains when dealing with the development of medieval artillery. Issues such as how long torsion engines remained in use and how early swing-beam engines were adopted in various regions remain open for debate. With such fundamental questions left unresolved, it is hard to discern the power of the artillery used between the sixth and eleventh centuries. From the end of the eleventh century, however, relatively detailed descriptions of artillery emerge from the theatre of the crusades, allowing for a comparatively good understanding of the artillery employed in the Levant during the twelfth and thirteenth centuries.

Unfortunately, most of the studies mentioned in this chapter have concerned themselves with only the most sensationalised accounts of artillery and have neglected the wealth of less detailed references that can help to construct a fuller picture. Likewise, few have attempted to incorporate archaeological evidence or a sound appreciation of the practical physics and mechanics that governed the use of trebuchet technology. Such shortfalls have allowed scholars to accept all too uncritically certain reported values, often provided by those with limited experience with siege engines, and propose that contemporary artillery was far more powerful than appears to have been the reality.[156] Although Viollet-le-Duc seems to have held the incorrect belief that *trebuchets*, *mangonels* and *pierriers* were all counterweight engines, he is still among a minority of

[154] Chevedden, "Invention," pp. 90-91.
[155] Chevedden, "Invention," p. 93.
[156] An extreme example of this is Saadé's belief that the artillery employed by Saladin at Saone could fire projectiles up to 1 km, Saadé, "Histoire du Château de Saladin," p. 998.

scholars who appear correct when suggesting that such engines were capable of little more than destroying battlements and creating a hostile environment for those defending the parapets in the twelfth and thirteenth centuries.[157] Before analysing the literary and archaeological evidence, a rudimental understanding of trebuchet mechanics is necessary.

157 Viollet-le-Duc, *Dictionnaire*, 1:344. See also *Dictionnaire*, 5:218-42.

2. The Physics

The term 'trebuchet' first appears in the late twelfth century. Because it has no classical roots, and seems only to have been used to describe swing-beam artillery, modern historians have embraced it as a broad technical term to describe the whole family of swing-beam stone-throwers. These engines are commonly divided into two groups based on the type of force that powered them: traction trebuchets relied on human strength, men pulling ropes attached to the end of the short arm; and counterweight trebuchets made use of a deadweight attached to the short arm. The difference in weight distribution led a traction model to rest with the tip of its heavier long arm on the ground and pulling ropes dangling from the end of short arm, while a counterweight model would rest with its beam vertical and the counterweight hanging directly below the main axle.

Function

Trebuchets make use of a beam fixed to a horizontal axis. By offsetting the pivot point along the length of the beam, the engine makes use of mechanical advantage: when sufficient downward force is applied to the end of the short arm of the beam, the end of the long arm rises a greater distance and at a quicker rate in proportion to its greater length. A sling is attached to the end of the long arm, allowing the projectile couched within to accelerate to an even greater velocity before release. The axle is elevated by mounting it on a framework, allowing the beam sufficient space to rotate. The ideal height of the main axle is determined by the power source. That of a traction trebuchet is determined by the distance a man can pull a rope, the axle being half this distance above the hands of the men providing the pulling power. For a counterweight trebuchet, the axle should be high enough to allow ample space for the weight attached to the short arm to accelerate downwards, but low enough to minimise structural strain and allow the counterweight to fall as efficiently, or vertically, as possible. Both ends of the beam must remain unrestricted through the firing sequence to achieve a reasonable degree of efficiency, allowing as much energy to be transferred to the projectile as possible. The remaining energy is then dissipated as the beam and counterweight swing back and forth before coming to rest.

To maximise the strength of the frame, and minimise the materials required, a triangular trestle was generally employed: two vertical triangles, often with a central vertical support bisecting them, set parallel to each other. These were joined to a horizontal base structure that added further support while the tops were connected by the main axle.[158] The long arm of a counterweight trebuchet would typically have been drawn back about 135° from its vertical position of rest. From a mathematical point of view, a greater angle would generate more energy, as the counterweight would fall a greater distance and reach a higher velocity. From a carpentry standpoint, the higher the axle is placed the more difficult it is to assemble the machine and the sturdier the accompanying structure must be to withstand the additional forces. Increasing the strength and stability of the structure would allow for a higher axle and the beam to be pulled back farther; however, the added strength would also permit the use of a longer beam and a heavier counterweight at the original loading angle. Because the latter would generally transfer the most energy, it would appear that the long arm of most counterweight trebuchets was 50% longer than the axle was high. While there was an ideal ratio of 3:2 between the length of the long arm and the height of the axle, the optimal dimensions were dictated by the length of the short arm.

Historical sources of the Late Middle Ages suggest a variety of supposed ideal ratios between the long and short arms of the beam. Marino Sanudo advised a ratio of 6:1 in the early fourteenth century, a proportion fairly close to ideal if maximum range is desired.[159] The theoretical mathematics suggest that the ratio should be slightly less than this, especially when throwing larger weights; however, my own personal experience, field testing and historical illustrations suggest that a ratio of 5:1 is a safe and effective arrangement when the counterweight outweighs the projectile by at least 100:1.

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[158] For examples, see **Figs. C2**, **C6-C8**, **C21**, **C22**, **F2-F6**, **F8-F11**, **F23**, **F25**, **F27**, **F34**, **G1-G7** and **G10**.
[159] Marino Sanudo, *Liber secretorum* 2.4.22, ed. Bongars, pp. 79-80, trans. Lock, pp. 135-36.

The simplistic but essential addition that makes this pivoting beam a practical weapon, whether traction- or counterweight-powered, is the sling.[160] The mechanical advantage is magnified as the projectile is forced to travel even farther, and thus faster, before it is released. One end of the sling was fixed near the end of the long arm while the other was fitted with a loop that slid over a hook or metal 'finger' extending from the end of the beam. The low friction of the metal finger allowed the loop to slide free and unleash the couched projectile at the point of release. For counterweight engines, by adjusting the length of the sling, and even the angle of the finger, the point at which the looped end slipped free could be finely altered to change the angle of release without altering the mass of the counterweight. The handheld staff-sling, Vegetius's *fustibalus*, was little more than a stick with a similar sling and finger arrangement at its end.[161] The simplicity of the traction trebuchet allowed it to remain in use throughout the Middle Ages.

Whereas the mathematics show that a sling of equal or near-equal length to the long arm of the beam is ideal, a slightly shorter length is often more effective in the field, due to various mechanical inefficiencies. In the case of the counterweight model, a long sling allows for maximum mechanical advantage, while adding only negligible mass to the system. By extending the sling horizontally between the struts of the engine, the projectile is forced to travel as far as possible as efficiently as possible: by sliding horizontally, rather than hanging freely, the retarding resistance that the projectile exerts against the beam is limited before it is lifted off the ground. Furthermore, by positioning the projectile roughly horizontal to the tip of the long arm of the beam, the distance it must travel before release is maximised. Collectively, these factors all contribute to a higher release velocity.

For traction trebuchets, the distance that the short arm falls during a firing sequence is much shorter, fundamentally limited by the distance that an individual can efficiently pull a rope. Accordingly, the projectile is often held by an additional person during the early stages of pulling.[162] This allows all slack to be taken up and the beam to flex before the projectile is pulled loose. This maximises the efficiency of the crew's pulling motion while drawing further energy from the structure of the beam, forcing the

[160] The sling is such an intrinsic part that Jim Bradbury is willing to call any medieval engine that possessed a sling a 'trebuchet', Bradbury, *The Medieval Siege*, pp. 262-63.
[161] Vegetius, *Epitoma Rei Militaris* 3.14, ed. Lang, pp. 98-99. See also **Figs. A3-A6**.
[162] See **Figs. B19** and **B20**.

projectile to accelerate more quickly and travel through a broader arcing path prior to release. Sling length would vary by machine but would typically be about half the length of the long arm.

Traction

The traction trebuchet had the benefit of being a fairly light engine. It was simple to assemble, and shift if necessary, and could be operated by crews with little experience. When worked by trained teams in relay, traction trebuchets were capable of maintaining high rates of fire over extended periods of time. Kelly DeVries suggests that trained crews could have sustained what seems to be a fairly reasonable rate of four shots per minute over the course of an hour, a rate that was achieved over shorter periods by Tarver in trials using relatively untrained volunteers.[163] Although this method of propulsion sacrificed accuracy, as the force with which each crew member pulled invariably fluctuated, a traction trebuchet could be loaded with a variety of projectiles. Incapable of consistently reproducing the exact same firing sequence, it did not require the finely shaped stone balls necessary to achieve a precise trajectory shot after shot. This, along with its high rate of fire, meant that roughly tooled stones or fieldstones were suitable ammunition.

Whereas the power of a given counterweight trebuchet is limited by the amount of strain that its framework and primary components can withstand, traction models have much more finite limitations. The end of the short arm cannot travel a linear distance greater than the distance that each team member can pull (less than 1.5 m). This not only limits the scale of the engine but also the space in which crew members can stand under the short arm: with every additional puller, the direction of force spreads outwards. Power can thus be increased only to a limited extent by adding additional pullers. If the pullers are positioned behind the axle, rather than below the short arm, there is near limitless room; however, the distance that an individual can pull horizontally is less than they can pull vertically downwards. Furthermore, while something as simple as a block, ring or bar might be adequate to redirect the lateral pull of the crew into a downwards force

[163] DeVries, *Medieval Military Technology*, p. 137; Tarver, "The Traction Trebuchet," pp. 58-59. DeVries' estimation is based largely on the figures provided from siege of Lisbon in 1147, see Chapter 4.

against the short arm, there is no evidence that this was ever done. The physics also prevents crews from pulling in stages or relays during a single firing sequence. Even with hugely exaggerated components, neither the rate of acceleration nor true velocity would have been sufficient to create a practical firing scenario. Although there are historical illustrations of crews standing behind the axle of an engine, these are relatively rare and do not appear to reflect a common practice.[164]

Thus unlike the counterweight trebuchet, the scale and structural strength of a traction trebuchet cannot simply be increased to reflect added force to the short arm. For this reason we do not find reliable accounts of 'super' traction trebuchets. In most historical references to exceptional traction trebuchets, the crew numbers are exaggerated rather than the proportions of the machine, indicating that the writer had an understanding of the engine's power source but not of its mechanics. Accounts of teams composed of hundreds of pullers, which some modern historians have taken literally, can be dispelled as pure hyperbole. DeVries's suggestion that early traction trebuchets were powered by teams of between 40 and 250, with one or two men to a rope,[165] should therefore be treated with extreme caution, as should the description of 600 men powering a traction trebuchet at the siege of Damietta in 1218.[166]

Because of the fundamental limit imposed on the length of the short arm by the distance an individual can pull, and the knock-on consequences that this has for the proportional size of other components, the optimal size for any team is generally around ten. This number allows everyone to stand directly under the short arm and maximise the transfer of potential energy. This is a happy medium between standing farther back towards the axle, which would increase rotation but add greater resistance, and standing farther away, which has the opposite effect. Experimental trials using reconstructed engines have confirmed this as the ideal position of the pulling crew as well as the redundancy of any more than about ten to twelve pullers.[167]

[164] See **Figs. B16** and **B25**. Perhaps the closest mechanical solution might have been to dispense with the short arm and exaggerate the axle, as was been done with the counterweight engine in **Fig. F32**, drawn by Leonardo da Vinci. There is no evidence that such an engine was ever built.

[165] DeVries, *Medieval Military Technology*, p. 133-34.

[166] *History of the Patriarchs*, trans. Khs-Burmester et al., 3.2:218. Cf. Chevedden, "King James I," p. 324.

[167] For a documented case study, see Tarver, pp. 157-58. These findings have been confirmed by the crews operating the traction trebuchets both at Caerphilly castle and the Middelalder Centret.

Hybrid

In an attempt to validate textual references to excessively large teams of pullers, Chevedden has developed his theory of a 'hybrid-trebuchet': a traction-type fitted with a counterpoise to offset the superior weight of the long arm.[168] This is a practical innovation when dealing with small engines and may have been inadvertently added through the necessary structural supports if a fanning 'rake' was added to secure a broader 'foot' at the end of the short arm. This addition, to which the pulling ropes were attached, effectively increased the area in which the pullers could stand below the short arm.[169]

Chevedden argues that a counterpoise was added to heavier traction trebuchets with the aim of throwing larger projectiles. Adding mass to the short arm of a heavy beam would assist in raising the long arm; however, because the length of the short arm must remain the same, the force provided by the pulling crew must be increased in proportion to the overall weight of the beam, otherwise it will not accelerate sufficiently during the firing sequence. While this would theoretically render larger crews appropriate, the same issues of space that limit the number of pullers that can operate a lighter traction trebuchet remain. Because the short arm of a counterweight trebuchet can be lengthened, and all other components enlarged accordingly, the beam of a larger engine can accelerate at a lower rate due to the longer firing sequence, ultimately reaching a higher velocity at the point of release. It is through the unrealistic requirement of exceptionally large crews, occasionally mentioned in the sources, that Chevedden attempts to justify his theory, the impracticalities of which have already been addressed. Intrigued by the potential of such an engine, the Danish Middelaldercentret attempted to reconstruct such a machine but found it to be a complete failure.

For these reasons it is extremely unlikely that traction trebuchets ever threw anything of significant mass or were at any point considered a breaching weapon. Although the concept of a transition stage in the development of the counterweight trebuchet is appealing, it seems entirely impractical.[170] The traction trebuchet was most

[168] Chevedden argues the hybrid-trebuchet was developed under Islamic rule in the early eighth century and by the ninth had spread through the Byzantine Empire to northern Europe. He contends that such a machine was used by the Crusaders against Lisbon (1147) as well as Damietta (1218), Chevedden, "Invention," p. 74; Chevedden, "King James I," pp. 324-25.

[169] For illustrative examples, see **Figs. B16** and **B19**-**B21**.

[170] The assumed existence of hybrid-variants has so permeated scholarship that Kostick notes the use of such at the siege of Jerusalem in 1099 without any reference to Chevedden in his bibliography. He, however, also suggests that torsion engines were present at this siege, Kostick, *The Siege of Jerusalem*, pp. 82-83.

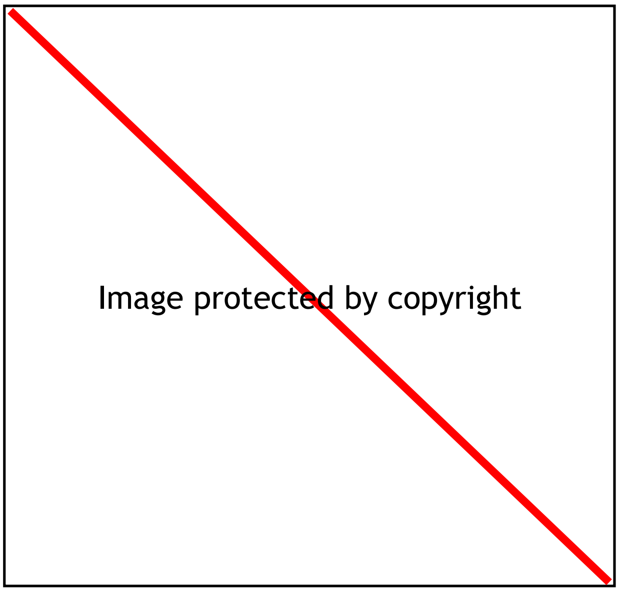
effective as an antipersonnel weapon. It was reliable, affordable and required minimal skill and time to construct and operate. It was relatively mobile and could easily be grouped with others to concentrate fire. It was able to take advantage of ammunition that could be gathered locally and prepared with minimal time, cost and expertise yet could threaten the integrity of crenellated parapets over extended barrages.

Counterweight

Rather than replace the traction trebuchet, the counterweight trebuchet supplemented it. By using dead weight rather than pullers to propel the short arm downwards, the amount of force that could be applied was limited only by the strength of the beam, axle and framing. But this power came with drawbacks. The much larger size and weight of each component, as well as the stresses involved, necessitated a higher level of engineering competence and required more time and money for construction. The machine's rate of fire is also considerably lower than that of a traction trebuchet, as after each shot any energy that has not been transferred to the projectile is dissipated through a subsequent swinging process. This period of post-release swing is longer for those engines that make use of a fixed counterweight. A counterweight that is attached with a hinge will fall straighter, thus allowing for a more efficient transfer of energy, while one that is firmly fixed to the short arm will fall in a wider arc, remaining a constant distance from the main axle. Once still, the machine then had to be cocked. To pull the long arm back down from its vertical position of rest, thus lifting the short arm and its accompanying load, treadwheels or winches were required for the largest engines while the beams of smaller engines could be pulled into place manually with ropes. The amount of time it took to cock each engine and the number of men required to do so varied according to the size of the machine. It normally takes between 10 and 30 minutes for a modern reconstructed engine to complete a full firing and reloading sequence. Ammunition for counterweight trebuchets was typically specialised. Because of the uniform power behind each shot, the machine's accuracy was remarkably consistent provided projectiles of equal mass and shape were used; however, this required additional investments of money and time as each stone had to be shaped by a mason or stonecutter.[171]

Shaduf (from _Descriptions de l'Égypte_)

Tollenno (from Roberto Valturio, BNF, MS lat. 7236)

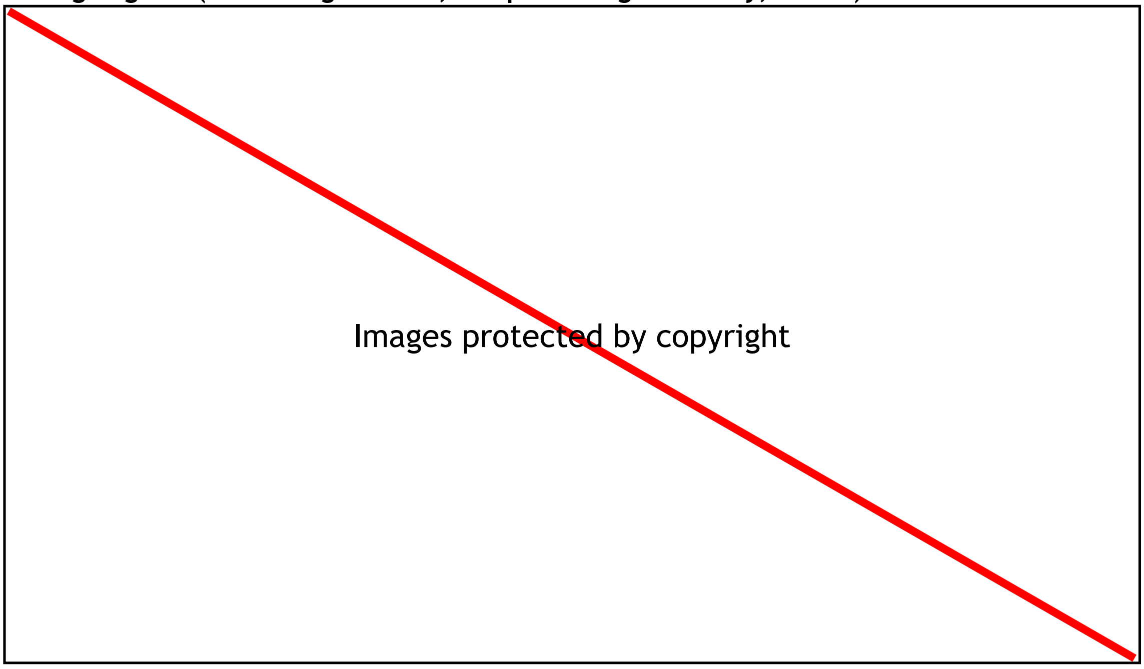


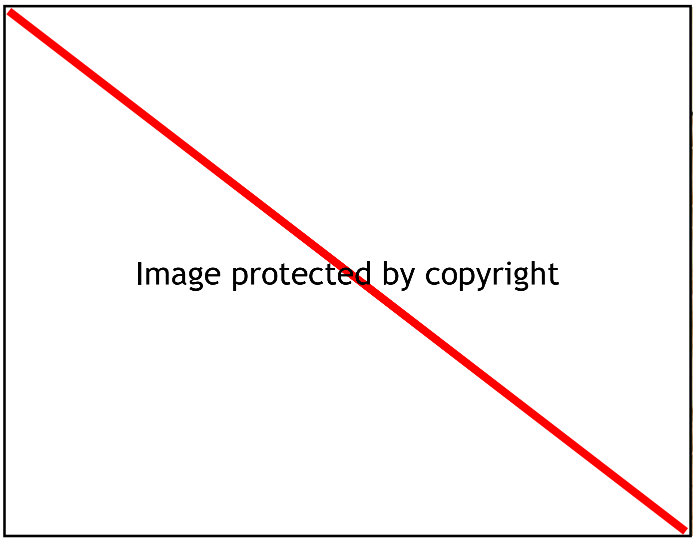
Despite its drawbacks, this was the most powerful form of artillery to be used in Europe and the Near East until the bombard was introduced. While there is little evidence that such engines breached curtains and pulverised towers through the twelfth century and most of the thirteenth, the fact that they could remove battlements and expose defenders along parapets to antipersonnel fire without the need to construct expensive, complicated and vulnerable siege towers was a notable achievement. Furthermore, the psychological effects of such engines should not be underestimated.

The basic mechanics of a counterweight trebuchet are very simple and had been understood for centuries. The ancient *shaduf*, which had been used for millennia in Egypt to bring up water from the Nile, was based on a similar design. In the West, the *tollenno*, described by Vegetius, made use of a 4:1 fulcrum and counterweight to elevate men to a besieged parapet.[172] Although the engine described by Vegetius might have been more imaginative than practical, evidence from the mid-thirteenth century Morgan (Maciejowski) Bible suggests the concept was familiar at that time.[173] Adding to this the known concept of the

[171] On 30 June 1224 Henry III summoned an additional 30 quarrymen and stonecutters to shape projectiles to be used against Bedford, Amt, "Besieging Bedford," p. 111. There is evidence that standardised ammunition was stored in Northumberland during the Middle Ages, Hill, "Trebuchets," p. 104.
[172] Vegetius, *Epitoma Rei Militaris* 4.21, ed. Lang, pp. 142-43.
[173] Although these images postdate the earliest illustrations of counterweight trebuchets, only traction trebuchets are depicted in this particular source.

Lifting engines (from *Morgan Bible*, Pierpont Morgan Library, M.638)





Roman *onager* and staff sling, and it is perplexing that the counterweight trebuchet, far simpler and more effective than the twisted columns of sinews and hair that powered Greek and Roman torsion machines, was not developed earlier.[174] These engines make use of the same simple principle that allows children to lay a spoon across some kind of fulcrum and catapult peas at the dinner table. In his discussion of siege engines, Vitruvius dedicated significant space to dealing with torsion weapons, shelters and towers but deliberately omitted ladders, cranes and such machines that operated on much simpler principles, as he claims that these could be constructed by the ordinary soldier without guidance.[175]

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[174] Hill tries to argue the opposite, suggesting the initial failure to utilise a long sling may have been responsible for the delayed development of the counterweight trebuchet, Hill, "Trebuchets," pp. 108-9.
[175] Vitruvius, *De architectura* 10.16.1, ed. Krohn, p. 257, trans. Morgan, p. 315.

The Mathematics

Abbreviations

Mcw	Mass of the counterweight (kg)
Mp	Mass of the projectile (kg)
Mb	Mass of the Beam (kg)
Lb	Length of the beam (m)
Lla	Length of the long arm (m)
Lsa	Length of the short arm (m)
Ls	Length of the sling (m)
Lcw	Length of the counterweight's centre of mass from the beam (m)
Lax	Height of the main axle (m)
Hcw	Displacement of the falling hinged counterweight (m)
r	Radius of the projectile (m)
Ap	Cross-sectional area of the projectile (m)
Ek	Kinetic energy (J)
Ep	Potential energy (J)
Eff	Efficiency (%)
Rmax	Maximum theoretical horizontal range (m)
Rh	Horizontal range (m)
Rv	Vertical range (m)
V	True velocity of the projectile at release (m/s)
Vmax	Maximum theoretical release velocity (m/s)
Vh	Horizontal velocity (m/s)
Vv	Vertical velocity (m/s)
Ib	Moment of inertia ($kg \cdot m^2$)
Tf	Flight time (s)
g	Acceleration due to gravity ($9.8 m/s^2$)
ρ	Density of air ($j/kg \cdot K$)
C	Coefficient of drag (shape dependent)
Dc	Drag constant
θ	Angle of the short arm to the vertical below the beam
ϕ	Angle of the short arm to the vertical hanging counterweight
ψ	Angle of the long arm to the loaded sling
α	Angle of release to the horizontal

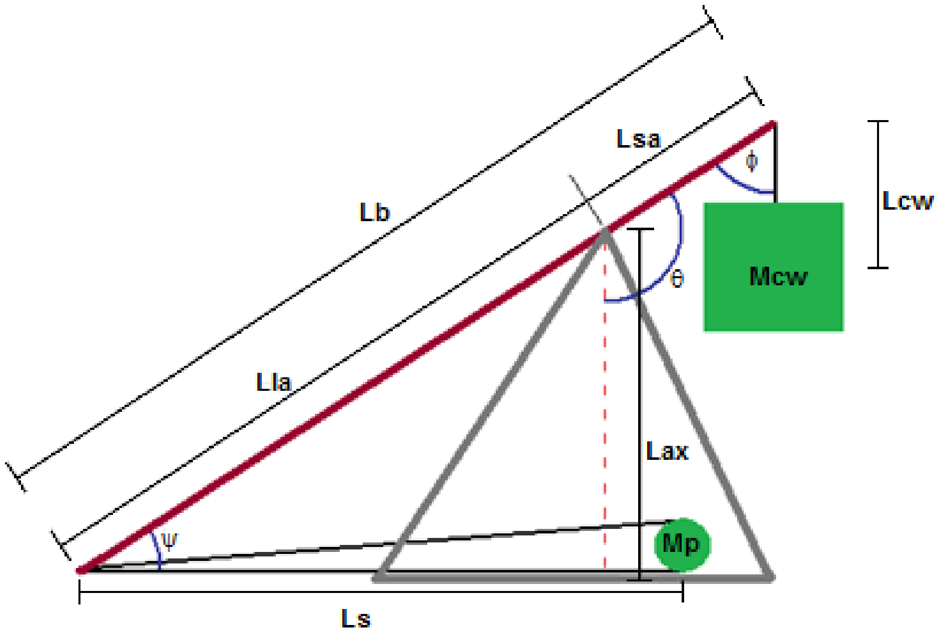
For clarity all angles with be represented in degrees but calculated in radians

Arrangements A, B, C and D[176]

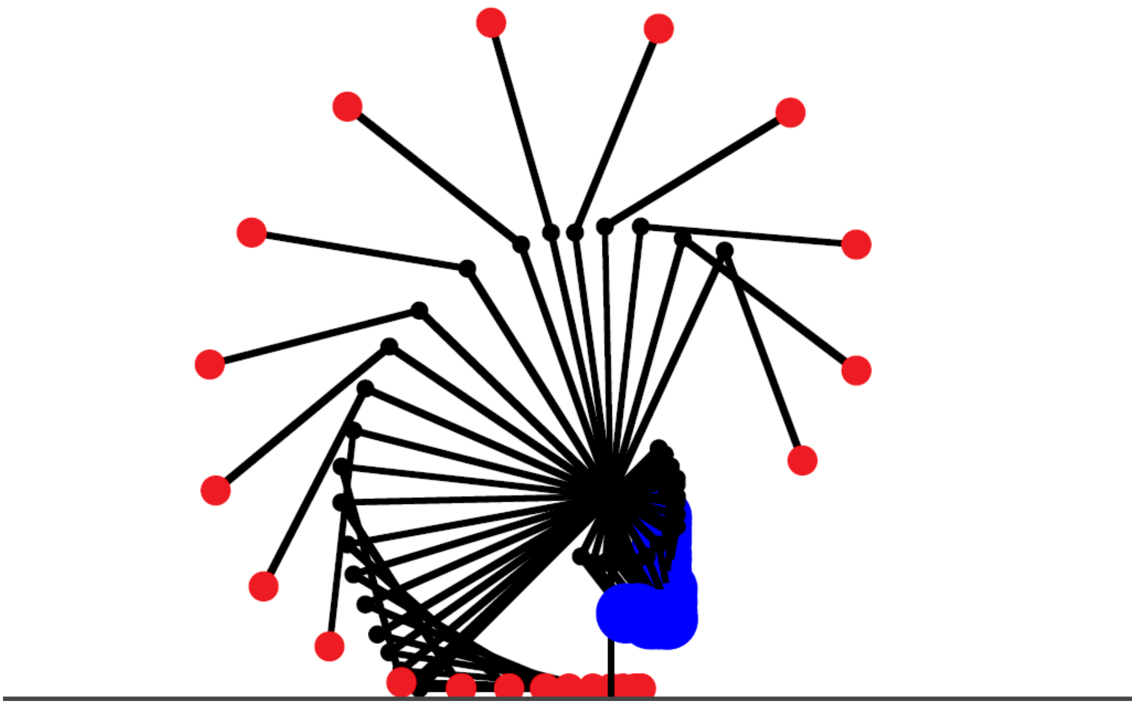
	Arrangement A	*Arrangement B*	*Arrangement C*	*Arrangement D*
Lla	10 m	4 m	1.22 m (4 ft)	8 m
Lsa	2 m	1 m	0.30 m (1 ft)	2 m
Lb	12 m	5 m	1.52 m (5 ft)	10 m
Lcw	2 m	1 m	0.30 m (1 ft)	2 m
Ls	10 m	4 m	0.99 m (3.25 ft)	6 m
Mcw	10,000 kg	1,000 kg	45.36 kg (100 lb)	5,000 kg
Mp	100 kg	10 kg	0.45 kg (1 lb)	20 kg

[176] Arrangements A and B are based on values used by Donald Hill, Arrangement C is a roughly optimal set of values provided by Donald Siano and Arrangement D is an original data set.

Components of a counterweight trebuchet



Firing sequence of a hinged counterweight trebuchet (from Siano)



It is relatively simple to express each mathematical component of a counterweight trebuchet: the system is little more than three masses and three axles, powered by the force of gravity. However, it is extremely complicated to represent a complete firing sequence as each component complicates the equation geometrically. For purposes here, the function of a counterweight trebuchet will be analysed; traction trebuchets operate on the same essential principles but the lack of a uniform and consistent downward force makes it very difficult to express a firing sequence mathematically.

Following Hill's first attempt to express the function of a counterweight trebuchet in mathematical terms, more detailed studies have been put forward by mathematicians and mechanical engineers. Although the essentials are of a high-school level, the full process is extremely difficult to express without computer software. Today the foremost mathematical representations of trebuchet dynamics are offered by Mark Denny and Donald B. Siano. Siano employs complex numerical models using Mathematica programming, plotted using Cartesian coordinates. Denny's range-based study is more approachable but still relies on a numeric rather than algebraic evaluation of a complete counterweight trebuchet.[177] For clarity, the basic components will be outlined, loosely following Denny's model, to the limits that basic algebra will allow.

Energy System

At its core the firing process of a trebuchet is simple: potential energy stored in the suspended counterweight is transferred through the firing sequence to the projectile couched in the sling.[178] Thus a simplified expression for maximum range can be expressed if the masses and measurements of the basic components are known:

$$\mathrm{Rmax} = 2\left(\frac{\mathrm{Mcw}}{\mathrm{Mp}}\right)\mathrm{Hcw}\cdot\mathrm{Eff}$$

[177] Denny, "Siege Engine Dynamics," 561-77; Siano, *Trebuchet Mechanics*. See also Denny, *Ingenium*, pp. 61-91. Siano's work has served as the exclusive mathematical basis for studies such as Saimre, "Trebuchet," 61-80. I am deeply indebted to Mark Denny for the innumerable scenarios and setups he has run through his algorithms to test the viability of various theories that I have come up with, which stretch far beyond the parameters of his article. For a more simplistic introduction to the physics of this mechanical process, see Chevedden, et al., "The Trebuchet: Recent Reconstructions and Computer Simulations," pp. 66-71.

[178] For working through the basic trigonometry and helping provide the essential platform from which I built my numerical representation of the firing system, I would like to thank Ross Underhill.

Or, if the velocity and angle of release are known:

$$\text{if Vh} = \text{V} \cdot \cos\alpha$$

$$\text{and Vv} = \text{V} \cdot \sin\alpha$$

$$\therefore \text{ Rh} = 2\,\text{V}^2 \left(\frac{\sin\alpha \cdot \cos\alpha}{\text{g}}\right)$$

$$\text{and Tf} = 2\left(\frac{\text{Vv}}{\text{g}}\right)$$

The maximum potential velocity of a perfectly efficient system (Eff = 1) can also be shown or, alternatively, the efficiency of a system with a known velocity:

$$\text{if Rmax} = 2\left(\frac{\text{Mcw}}{\text{Mp}}\right)\text{Hcw}$$

$$\text{where Hcw} = \text{Lsa}\,(1 - \cos\theta)$$

$$\therefore \text{ Vmax} = \sqrt{2\left(\frac{\text{Ep}}{\text{Mp}}\right)\text{Eff}}$$

$$\text{and Eff} = \text{V}^2\left(\frac{\text{Mp}}{2\text{ EP}}\right)$$

$$\text{where EP} = \text{Mcw} \cdot \text{Hcw} \cdot \text{g}$$

The energy within the projectile can also be shown:

$$\text{EK} = \text{V}^2\left(\frac{\text{Mp}}{2}\right)$$

$$\text{or EK} = \frac{1}{2}\text{Mp} \cdot \text{V}^2$$

Although convenient, these representations are drastic simplifications and as representations of an actual engine they fail to take into account factors such as the mass of the beam. For the sake of simplicity, certain modelling limitations will continue to be observed, notably that this remains a frictionless system (unless represented by Eff), the sling is considered to have no mass, the beam has a uniform cross-section, and every component is rigidly defined so that there is no flex or stretch at any point though the firing sequence.

Mechanical System

To model the mechanics of a trebuchet, it is helpful to start with the beam itself. Devoid of a sling or hinged counterweight, maximum release velocity is achieved at a release angle of 0° (horizontal):

$$\mathrm{V} = \mathrm{Lla}\sqrt{2\left(\frac{v}{\mathrm{I}}\right)(\sin\theta + \cos\alpha)}$$

$$\text{where } v = (\mathrm{Mcw}\cdot \mathrm{g}\cdot \mathrm{Lsa}) - (\mathrm{Mp}\cdot \mathrm{g}\cdot \mathrm{Lla}) - \left[\mathrm{Mb}\cdot \mathrm{g}\left(\frac{\mathrm{Lla}-\mathrm{Lsa}}{2}\right)\right]$$

$$\text{where } \mathrm{I} = (\mathrm{Mcw}\ \cdot \mathrm{Lsa}^2) + (\mathrm{Mp}\cdot \mathrm{Lla}^2) + \mathrm{Ib}$$

$$\text{where } \mathrm{Ib} = \frac{1}{3}\mathrm{Mb}\left(\frac{\mathrm{Lla}^3 + \mathrm{Lsa}^3}{\mathrm{Lla} + \mathrm{Lsa}}\right)$$

The impracticality of this arrangement, the dinner table model, is obvious. If *Arrangement A* is used and the beam is loaded at 135°, a projectile released at 45° will travel 26.57 m/s or 29.19 m/s at 0°. Only 10% of the kinetic energy within the machine is transferred to the projectile and only about 4% of the potential energy stored within the counterweight is communicated to the projectile.[179] Although this beam-only arrangement is entirely impractical, what should be highlighted is that when the mass of the projectile is reduced the launch speed intuitively increases but the efficiency of the system decreases, a trend that continues as additional components of complexity are added.

The next mathematical component to be added is a hinged counterweight. Although it seem very unlikely that a counterweight trebuchet was ever practically

[179] $\mathrm{EK} = \frac{\mathrm{Mp}\cdot\mathrm{Lla}^2}{\mathrm{I}}$. With so little energy conveyed to the projectile, most of the remainder would cause a long period of beam swing, further decreasing the potential rate of fire.

employed without a sling, such an arrangement is shown in **Figs. D5-D7**. In a scenario where it is desirable to throw an extremely large projectile, relative to the corresponding counterweight, only a short distance, the absence of a sling is actually beneficial. This scenario can be simplified to reflect an ideal scenario, when the centre of mass of the counterweight is in line with the long axis of the beam:

$$V \approx \sqrt{\frac{v[\sin(\theta - 90°) + \cos\alpha] - \mathrm{Mcw} \cdot \mathrm{Lcw} \cdot g(1 - \cos\alpha)}{\frac{1}{2}(\mathrm{Mp} \cdot \mathrm{Lla}^2 + \mathrm{Ib})}} \cdot \mathrm{Lla}$$

Arrangement A yields a release velocity of 31 m/s at a release angle of 45°, or 37 m/s if release occurs, impossibly, at 0°.

The addition of a sling, to the rotating beam and hinged counterweight, significantly complicates the mathematics. Furthermore, there arises the need to place a restriction on the initial path of the projectile, representing its horizontal slide before it is lifted into the air; without this, the projectile's natural arc would travel below its initial elevation. Rather than digging a trench to allow for this, using a low-friction trough increases the efficiency of the system. But as this represents a complete counterweight trebuchet, so too is it unfeasible to express this scenario algebraically and little can be expressed here aside from what has already been provided by Siano and Denny.[180] The last component to add is the low-friction 'finger'.[181] Although some analysts regard the angling of the finger as a significant design component,[182] personal experience has revealed that this is more practically a point of fine tuning.[183] Similarly, theories surrounding the 'propping' of the counterweight, as seen in **Figs. F9** and **F23**, will not be discussed.[184]

Using Mathematica, Siano sums up the comparative results between the various scenarios discussed above using *Arrangement C*, each provided with an optimal release angle for maximum range:[185]

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[180] See Siano, *Trebuchet Mechanics*, pp. 15-20. Cf. Denny, "Siege Engine Dynamics," pp. 572-74.
[181] For a mathematical representation of the 'finger', see Siano, *Trebuchet Mechanics*, pp. 25-31.
[182] For example, Saimre, "Trebuchet," p. 71.
[183] These sentiments are also shared by Peter Vemming, see Vemming Hansen, "Experimental Reconstruction," p. 202.
[184] I have found nothing to suggest that this practice was employed during the period of the crusades. The impracticalities involved are sufficient to question whether this practice was ever effectively employed.
[185] Siano, *Trebuchet Mechanics*, p. 22.

Arrangement C	*Angle of Release*	*Horizontal Range*	*Time to Release*	*Efficiency*
Beam-only	38.0°	38.4 ft (11.70 m)	0.40 s	11%
Hinged CW, no sling	22.6°	203 ft (61.87 m)	0.36 s	59%
Hinged CW, sling	18.4°	284 ft (86.56 m)	0.40 s	83%
Hinged CW, sling (with 2.27 kg beam)	19.3°	228 ft (69.49 m)	0.46 s	67%

The addition of a hinged counterweight and sling significantly increase both range and efficiency; however, these values decrease notably when the beam is given mass. This reinforces how each mechanical component contributes to the overall efficiency of a trebuchet, although certain retarding elements as friction are still omitted here.

At this point the decelerating force of drag can be factored in, determined by a numerically defined drag constant:

$$\mathrm{Dc} = \frac{\mathrm{C} \cdot \rho \cdot \mathrm{Ap} \cdot \mathrm{V}^2}{2}$$

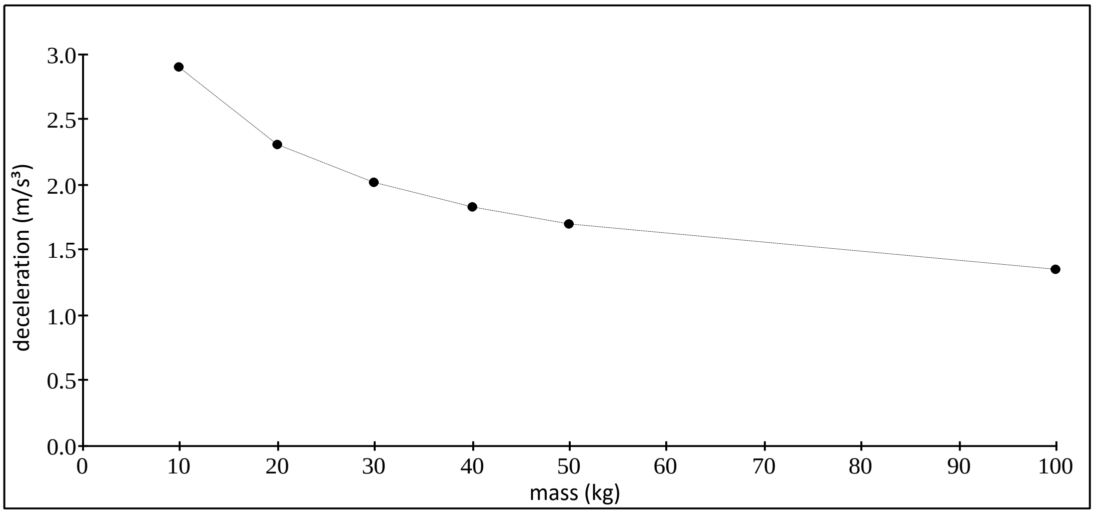
where, for a sphere, C ≈ between 0.45 and 0.50

$$\text{Horizontal deceleration} = \mathrm{V} \cdot \mathrm{Vh} \left(\frac{\mathrm{Dc}}{\mathrm{Mp}}\right)$$

$$\text{Vertical deceleration} = \mathrm{g} - \mathrm{V} \cdot \mathrm{Vh} \left(\frac{\mathrm{Dc}}{\mathrm{Mp}}\right)$$

Both horizontal and vertical deceleration are expressed as positive values (rather than negative acceleration)

Using a drag coefficient of 0.5, reflecting a near spherical projectile, the graph below demonstrates the rate of horizontal deceleration of projectiles with masses between 10 and 100 kg (with a consistent density of 2,500 kg/m^3). The initial release velocity here is 67 m/s and at an angle of 45°; the temperature is around 15°C; the air pressure is about 101.325 and generally dry:



This geometric distribution is important: although much lighter projectiles are often selected to maximise release velocity, they will decelerate more rapidly than heavier projectiles. Accordingly, many modern reconstructed counterweight trebuchets fire projectiles around 10 kg, which provide a balance between release velocity and in-flight performance. But returning to energy, a light projectile will sacrifice efficiency for range, while an efficient shot will never achieve maximum range. If air resistance is again negated, *Arrangement A*, with a 45° release angle, yields a theoretical range of 171.1 m, or 317.9 m if a 10 kg projectile is substituted.[186] Even when the higher rate of in-flight deceleration is factored in the far lighter projectile, which enjoys a much higher release velocity, will travel considerably farther.

Arrangement A
100 kg projectile at release

Arrangement A
10 kg projectile at release

[186] These figures have been generated using Siano's 'Trebuchet Simulator'.

Ideal Proportions

Hill's earlier expression of the firing process of a trebuchet with a hinged counterweight is somewhat simpler in approach than those of Denny and Siano, but like those of his successors, is constructed around an attempt to maximise potential range. Assuming a 135° loading angle and 45° release angle, Hill bases his calculations on a 50-grade timber beam weighing 35 lbs/ft^3 (560 kg/m^3) and working fibre stress of 3,000 lbs/in^3 (83,039,714 kg/m^3). With this he constructed a compound pendulum to yield a theoretical range (using $Rh = \frac{v^2}{g}$).[187] When comparing his results with those achieved by the engine reconstructed by Louis-Napoleon and Favé, Hill determined that their efficiency was about 56%. If neglecting air resistance, he believed a maximum efficiency of around 70% is achievable. Hill then applied this framework to two postulated machines:

	Mp	*Mcw*	*Lla*	*Ls*	*Rh*
Machine 1	45.36 kg (100 lb)	4,535.92 kg (10,000 lb)	9.14 m (30 ft)	4.57 m (15 ft)	224.03 m (245 yd)
Machine 2	226.80 kg (500 lb)	9071.85 kg (20,000 lb)	14.63 m (48 ft)	9.14 m (30 ft)	260.60 m (285 yd)

By adjusting the length of the short arm, preserving a ratio of between 6:1 and 5:1, these are the maximum theoretical ranges that Hill was able to achieve after factoring in an efficiency of 70%.[188]

Siano concurs that the maximum mechanical efficiency of a counterweight trebuchet is just over 70%. Summing up his findings, Siano roughly defines the ideal set of proportions as stemming from the mass of the beam and length of the short arm:[189]

$$Mp = 0.2 \cdot \mathrm{Mb}$$
$$Mcw = 2 \cdot \mathrm{Mb}$$
$$Ls = 3.75 \cdot \mathrm{Lsa}$$
$$Lla = 3.75 \cdot \mathrm{Lsa}$$
$$Hcw = \mathrm{Lsa}$$

[187] Hill, "Trebuchets," pp. 112-13.
[188] Marino Sanudo similarly recommended a ratio of 5:1 or 6:1 in the early fourteenth century, Marino Sanudo, *Liber secretorum* 2.4.22, ed. Bongars, pp. 79-80, trans. Lock, pp. 135-36.
[189] Siano, *Trebuchet Mechanics*, p. 41.

This, however, can be further improved by lowering the counterweight as much as possible so long as $Lax > Lsa + Lcw$.

The simplicity of the mechanics that govern a trebuchet made the construction and operation of such engines relatively easy. As there are so few components, each is necessary to produce efficient firing system but so too can they be easily manipulated to generate a fairly optimal set of proportions. Today, computer models are helpful tools and are increasingly being used to improve our understanding of historical mechanical processes.[190] However helpful, these are no substitute for real-world recreations, which not only express actual forces that are near impossible to compute, such as real-world friction and flux, but convey the functional issues associated with construction, operation and maintenance.[191] Although an understanding of the mathematics is not necessary to operate a trebuchet, by appreciating the governing physics the historical context can be better understood and the sources better evaluated.

[190] For example, Kooi, B. W. and C. A. Bergman, "An Approach to the Study of Ancient Archery," pp. 124-134.

[191] For a selection of reconstructed trebuchets, see Appendix 4.

PART TWO:

ARTILLERY IN THE SOURCES

3. Artillery and the First Crusade

A Baseline (1097-1099)

Unfortunately, no archaeological evidence survives to indicate the scale or even the form of the early siege engines used by the Franks during their conquest of western Syria and Palestine. We are therefore dependent on the surviving literary sources, which fortunately include a number of eyewitness accounts, even if the most detailed of them are all written from a Frankish point of view.

Nicaea: 1097

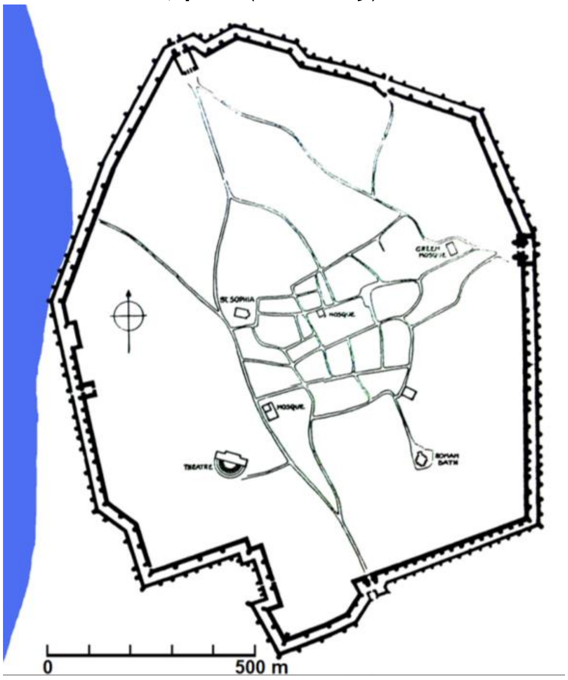
Having crossed Europe and entered Asia, the first challenge that faced the Frankish forces in Anatolia was the city of Nicaea.[192] A stronghold of the Eastern portion of the Roman Empire since the fourth century, considerable stretches of the city's classical defences can still be viewed today. Although the walls have not survived to their original height, when Raymond of Aguilers viewed them in 1097 he noted that Nicaea was surrounded "with such lofty walls that the city feared neither the attack of enemies nor the force of any machine."[193]

The first contingent of Franks arrived at Nicaea on 6 May 1097. The main force was followed by Raymond of St Gilles and the Provençal contingent a week later and

[192] The regional units which composed the larger army were roughly represented by Bohemond of Taranto, leading the Italian Normans, Count Raymond and St Gilles of Toulouse and papal legate Adhémar of Le Puy, heading the Provençals, Godfrey of Bouillon leading the Alsatian forces, and Hugh of Vermandois, Stephen of Blois, Robert of Normandy and Robert of Flanders with their respective followings.

[193] *Praeterea muris ita eminentibus cingitur, ut nullorum hominum assultus, nullis machinae impetus vereatur*, Raymond of Aguilers, *Historia Francorum* 3, RHC Oc 3, p. 239, trans. Hill and Hill, p. 25. For a detailed description of Nicaea's defences, see France, *Victory in the East*, pp. 143-44.

Nicaea: town, plan (after Toy)



Stephen of Blois arrived in early June, just in time to see the city surrender.[194] The sources make it clear that ballistic machines were used throughout the siege. The anonymous author of the *Gesta Francorum* and Guibert of Nogent relate that after the main body of Franks arrived they began to construct machines to aid their early attacks.[195] Raymond of Aguilers and Albert of Aachen note the construction of further artillery by the Provençal forces when they took up their position to the south of Nicaea.[196] One of the first tasks of these Provençal engines was hurling the heads of fallen Turks, members of a defeated relief force sent by Kilij Arslan, over the walls and into the city.[197] Raymond of Aguilers clearly states that the stone projectiles subsequently hurled by these engines had minimal effect. Albert of Aachen confirms this initial ineffectiveness but adds that when the number of engines was increased, from just two, some cracks were opened and a few stones fell free of the wall, a point reiterated and embellished by William of Tyre.[198] Fulcher of Chartres, traveling with Stephen of Blois' contingent, notes that *petrariae* and *tormenta* were built when their contingent arrived near the end of the siege.[199] Later sources also tend to stress that ballistic siege machines were employed by the crusaders.[200]

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194 *Gesta Francorum* 2.7-8, ed. and trans. Hill, pp. 13-17; Raymond of Aguilers, *Historia Francorum* 3, RHC Oc 3, p. 239, trans. Hill and Hill, pp. 25-26; Fulcher of Chartres, *Historia Hierosolymitana* 1.9.2-10.1, ed. Hagenmeyer, pp. 177-81, trans. Ryan, pp. 79-81. The *Gesta* places Robert of Flanders at the siege before the arrival of the Provençals while Fulcher states he arrived with Stephen of Blois only days before the siege ended.

195 *Gesta Francorum* 2.8, ed. and trans. Hill, p. 14; Guibert of Nogent, *Die gesta per Francos* 3.6-10, ed. Huygens, pp. 145-55, trans. Levine, pp. 62-66.

196 Raymond of Aguilers, *Historia Francorum* 3, RHC Oc 3, p. 239, trans. Hill and Hill, p. 26; Albert of Aachen, *Historia Ierosolimitana* 2.32, ed. and trans. Edgington, pp. 114-15, cf. 2.29, 32, pp. 110-11, 116-17.

197 *Gesta Francorum* 2.8, ed. and trans. Hill, p. 15; Guibert of Nogent, *Die gesta per Francos* 3.6, ed. Huygens, pp. 145-47, trans. Levine, pp. 62-63; Roger of Wendover, *Flores historiarum*, ed. Coxe, 2:83, trans. Giles, 1:394. Cf. *Chanson d'Antioche* 74, trans. Edgington and Sweetenham, p. 146. This force had been sent by Kilij Arslan, who was then busy besieging Melitene. Matthew of Edessa notes Kilij Arslan's use of artillery against Melitene, Matthew of Edessa, *Patmowt'iwn*, trans. Dostourian, pp. 163-64.

198 William of Tyre, *Chronicon* 3.8-9 (9-10), ed. Huygens, 1:205-8, trans. Babcock and Krey 1:161-63.

199 Fulcher of Chartres, *Historia Hierosolymitana* 1.10.6, ed. Hagenmeyer, pp. 185-87, trans. Ryan, p. 82.

200 For example, William of Tyre, *Chronicon* 3.6 (7), ed. Huygens, 1:203-4, trans. Babcock and Krey, 1:158-59; Roger of Wendover, *Flores historiarum*, ed. Coxe, 2:84, trans. Giles, 1:394.

Despite the clear presence of artillery, the contemporary sources all confirm its futility and failure to seriously damage the defensive masonry. A hexameter written by Robert the Monk, however, states that the Franks threw stones and other blunt munitions into the city rather than just against the walls, indicating that the Franks were at times not aiming at the mass of the walls but at the parapet or targets inside the city.[201]

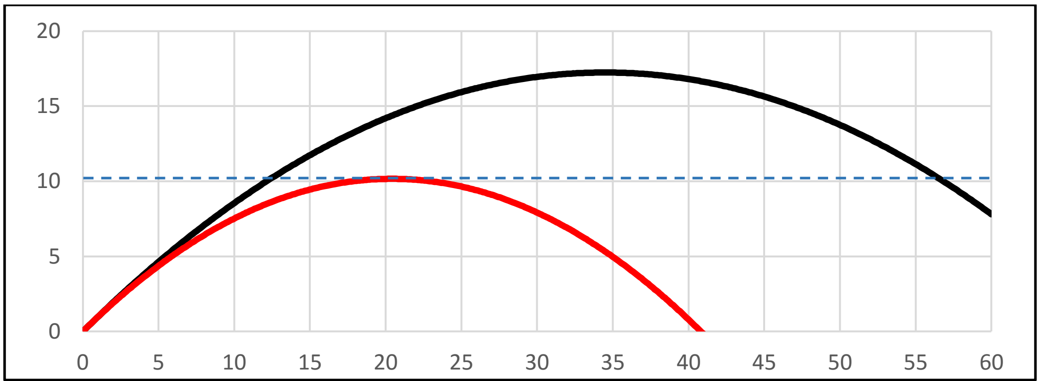
The damage inflicted by the time that Stephen of Blois had arrived was caused by mining rather than artillery. The contingents that had been working against the walls used penthouses to shield their sappers while artillery fire provided additional cover.[202] The extent of the damage to the walls is unclear as the Franks were denied the opportunity to assault them. After about seven weeks of siege, the garrison capitulated to a Byzantine force, which had made contact across the Ascanian Lake.[203]

What is perhaps most striking in this, the opening siege of the crusades, is the universal notice given to artillery by the contemporary sources. Most primary accounts note that the contingent of the army with which they were associated constructed such engines almost as soon as it arrived. This in itself strongly implies that each of the Frankish contingents had experience with machines of the types constructed at Nicaea before they had left for the East and that their use of them was nothing exceptional, suggesting knowledge of this technology was widespread in Europe by the end of the eleventh century.

If unable to threaten Nicaea's fortifications, the artillery that was used was powerful enough to throw a human head over the city's walls. If we assume that the walls had a height of 10 m, a release velocity of at least 20 m/s would be required to clear them at a release angle of 45°. This, however, would place the machine only slightly more than 20 m from the wall. Working from these figures, a rough scale of the trebuchets in question can be postulated. For example, a beam 3.5 m long with a ratio of 6:1, fitted with a 2 m sling, a counterweight of 600 kg (representing approximately the pulling force of eight to ten men) and a projectile of 3.5 kg (representing a human head), when loaded at

[201] Robert the Monk, *Historia Iherosolimitana* 3.3, RHC Oc 3, p. 756, trans. Sweetenham, p. 104.
[202] Raymond of Aguilers, *Historia Francorum* 3, RHC Oc 3, p. 239, trans. Hill and Hill, p. 26; *Gesta Francorum* 2.8, ed. and trans. Hill, p. 15; Guibert of Nogent, *Die gesta per Francos* 3.6, ed. Huygens, pp. 145-47, trans. Levine, pp. 62-63; Ralph of Caen, *Gesta Tancredi* 17, RHC Oc 3, p. 615, trans. Bachrach and Bachrach, p. 40; Anna Comnena, *Alexiad* 11.1, trans. Sewter, pp. 333-35; Albert of Aachen, *Historia Ierosolimitana* 2.30, 34-36, ed. and trans. Edgington, pp. 112-13, 118-25.
[203] Anna Comnena, *Alexiad* 11.2, trans. Sewter, pp. 337-38; *Gesta Francorum* 2.8, ed. and trans. Hill, pp. 16-17; Raymond of Aguilers, *Historia Francorum* 3, RHC Oc 3, pp. 239-40, trans. Hill and Hill, pp. 26-27. For an excellent analysis of the siege of Nicaea, see France, *Victory in the East*, pp. 143-69.

135° is capable of producing a release velocity of 37 m/s given the masses involved and initial load angle. If a reasonable mechanical efficiency of 70% is factored in, this decreases the release velocity to 26 m/s. A projectile travelling 26 m/s, released at 45° to the horizontal, can clear a 10 m wall from a range of 56 m.[204]



Velocity (V)	20 m/s	26 m/s
Release Angle (α)	45°	45°
Max. Horizontal Range (Rh)	40.8 m	69.0 m
Horizontal Range when at 10 m elevation (Rh when Rv = 10)	23.2 m	56.7 m

This very rough estimation of mechanical scale seems to fit both the capabilities and limitations suggested by the sources. Rather than breaching engines, the siege of Nicaea reveals that artillery was more likely used to support sapping efforts and other means of attacking a stronghold, targeting defenders rather than defences.

Despite every indication that the Franks had prior knowledge of the ballistic siege engines that they employed at Nicaea and that the power of these machines was not enough to classify them as breaching weapons, Paul Chevedden has argued that the Franks received counterweight trebuchets from the Byzantines in the lead up to the siege. The argument seems to be based entirely on the testimony of Anna Comnena, who was not an eyewitness of the siege and composed her account many decades after the events. In her description, Emperor Alexius, her father, judged that even with innumerable forces the Franks would not be able to take Nicaea. So, "he constructed *helepoleis* of several

[204] In this scenario, the beam has been given a uniform cross-section and mass of 40 kg. No more than a rough simulation can be offered due to the use of traction power: unlike a mass falling under the force of gravity and accelerating downwards at a fairly uniform rate, the variance and irregular force applied by a single puller, let alone a collection of such, prevents an accurate mathematical model. The dimensions given here are relatively similar to those of many modern reconstructions.

types, but mostly to an unorthodox design of his own which surprised everyone" and sent these to the Franks.[205] Prior to this, she claims the Franks made a brief attack on the walls of Constantinople during the uneasy period before they crossed the Hellespont but, at this point at least, they lacked any *helepoleis*.[206] This contrasts the numerous occasions prior to this where she claims that artillery was employed by various Byzantine commanders.[207]

Using Anna's account, Chevedden has argued that Alexius personally built the Franks a number of trebuchet-type machines, associating such engines with Anna's use of the term *helepoleis*.[208] In defending his position, Chevedden argues against the popular interpretation of these events, sensibly explained by Randal Rogers and John France. The latter suggest that Alexius might have helped the Franks in this regard by providing materials and possibly even some advice, but that knowledge of these machines was not foreign to the Franks and construction was almost certainly undertaken by Latin craftsmen. Chevedden's case is built in no small part on an absence of information and, while criticising the opposing perspective for its failure to acknowledge certain Greek sources, does precisely this with regard to Latin source material.[209] To take matters a step further, Chevedden uses Anna's praise for her father and his commission of 'various' and 'new' designs of his own imagination as evidence that this was the point at which the first counterweight trebuchet was conceived, designed by no less than Alexius himself.[210] Besides Anna's account, there is no evidence to justify such a claim. Thus although Greek aid should not be underemphasised in accounting for the early successes of the First Crusade, particularly with regard to provisioning, there is no reason to assume that the engines built by the Franks in Asia Minor were much different from contemporary engines built in southern Italy, greater France and western Germany, nor were they any more powerful.

As Rogers has pointed out, there are three essential ingredients necessary to build siege engines: timber, fasteners and manpower.[211] Timber was available in the environs

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205 Anna Comnena, *Alexiad* 11.2, trans. Sewter, p. 336.
206 Anna Comnena, *Alexiad* 10.9, trans. Sewter, pp. 319-20.
207 For example, Constantine Dalassenus's siege of Chios, Anna Comnena, *Alexiad* 7.8, trans. Sewter, p. 234.
208 Chevedden, "Invention," pp. 76-78. The term *helepolis*, 'city taker', appears to have been used as a fairly general term, used by various sources at various times to identify a variety of engines. For suggestions that this referred to a counterweight trebuchet at this point, see Chevedden, "King James I," p. 316; Dennis, "Byzantine Heavy Artillery," pp. 99-115. See also Chapter 1.
209 See Rogers, *Latin Siege Warfare*, p. 21-22; France, *Victory in the East*, p. 165.
210 Chevedden, "Invention," p. 86.
211 Rogers, *Lain Siege Warfare*, pp. 21-22.

of Nicaea while fasteners, nails and rope, would likely have been carried by any carpenters among the host, restocking from local merchants as opportunities presented themselves. With regard to personnel, Latin labour was in abundance. There is no evidence that a Byzantine engineering expert was present in the Frankish siege camp and the fact that the machines do not appear to have been disassembled and transported with the crusaders as they pushed east suggests that their form was quite simple. Construction of the Frankish artillery was most likely overseen by members of certain baronial households. Sometimes these individuals were retainers with demonstrated skill in this field while in many instances construction would be directed by a major lord himself.[212] Evidence of this at Nicaea is apparent with the construction of the early penthouses, while that built by the anonymous Lombard for the Lotharingians serves as a case of freelance profiteering by someone with certain transferable skills. Nicaea would prove to be a relatively easy success compared to the Franks' next challenge.

Antioch: 1097-98

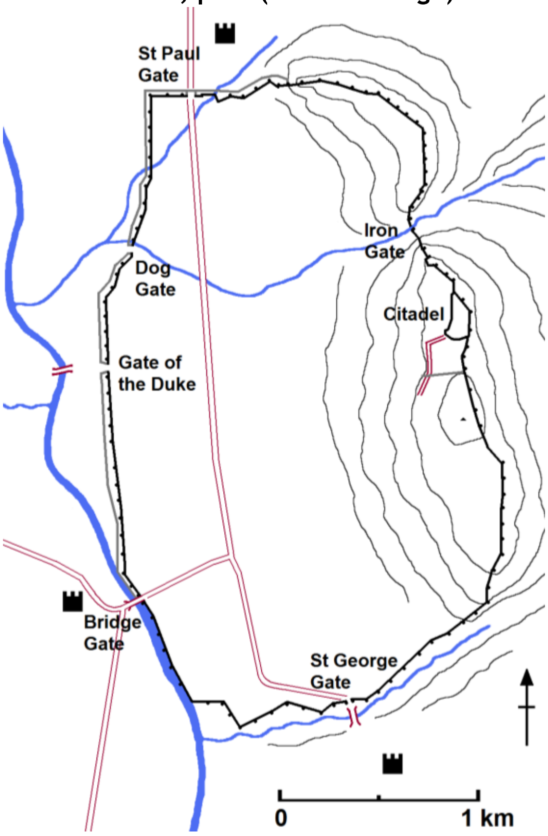
Antioch had long been a strongly defended city. Geographically, the city is the first major urban centre south of the Nur Daglari which, with the Taurus Mountains, encircle Cilicia, and is midway between the Mediterranean and the Jabal al-Nusayriyya, the northernmost extension of the mountains marking the Great Rift in the Near East. Antioch had remained a largely Christian city during the periods that it was ruled by Muslim potentates and had been under continuous Turkish rule for little more than a decade when the Franks arrived in 1097.

Although the city was taken a number of times over the preceding centuries, in most instances it fell to a surprise attack or treachery – most damage sustained by the city's fortifications was the result of earthquakes.[213] The walls were well provisioned with

[212] For the case of Robert of Bellême and Robert of Normandy in the decade leading up to the First Crusade, see Orderic Vitalis, *Historiae ecclesiasticae* 8.16, 24, ed. and trans. Chibnall, 4:232-37, 288-95.

[213] The Sassanids took Antioch by storm, scaling its Roman walls, in the 540s. The city burnt and depopulated before the attackers withdrew but its defences were left intact. The city walls were subsequently developed in the reigns of Justinian, Zimisces and Basil II. The city fell under Muslim influence during the Arab expansion but was retaken by Nicephorus Phocas in 968. About 1085, forces of the Seljuk sultan, Suleiman, took the city by surprise, those who had fled to the citadel were granted favourable terms after a short blockade, A. W. Lawrence, "A Skeletal History of Byzantine Fortification,"

Antioch: town, plan (after Asbridge)



large towers, spaced less than 50 m apart across exposed sections of the enceinte. The formidable strength of this city's now dilapidated defences still impresses, as it certainly did when the Franks viewed them in 1097. Raymond of Aguilers states that Antioch feared no besieging army regardless of its size.[214] Fulcher of Chartres claims that as long as those within were provisioned, the city could never be taken from without, while Stephen of Blois simply described Antioch as "very strong and unassailable" in a letter to his wife.[215]

The siege was opened on 21 October 1097.[216] The Franks adopted a strategy of close blockade and soon turned to siege forts to enforce this more strictly.[217] In the same way that it was taken by the Turks and Byzantines before them, the city was betrayed. After about eight months of siege, the Franks were able to enter the city one night in early June 1098 and by the next day the only remaining point of resistance was the citadel on top of Mt Silpius. This final bastion surrendered only days later, following the Frankish victory over Kerbogha of Mosul's relieving force.[218]

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pp. 196-97; Oman, *A History of the Art of War*, pp. 527-28; Matthew of Edessa, *Patmowt'iwn*, trans. Dostourian, pp. 147-48. Oman discounts any notion that the defences of Antioch were altered or improved in any way while the city was under Muslim control.

[214] Raymond of Aguilers, *Historia Francorum* 5, RHC Oc 3, p. 242, trans. Hill and Hill, p. 31.

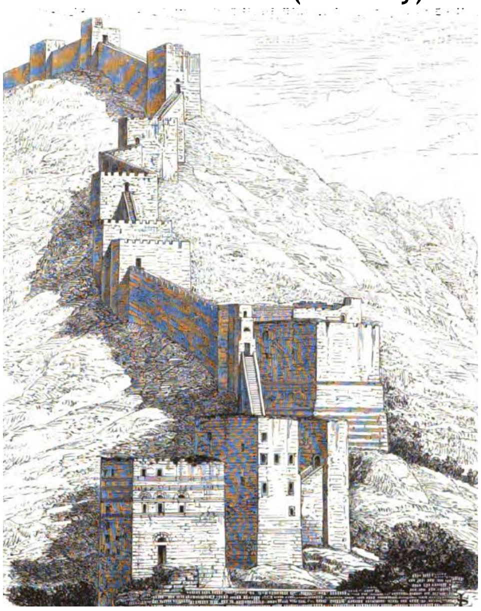
[215] Fulcher of Chartres, *Historia Hierosolymitana* 1.15.2, ed. Hagenmeyer, p. 217, trans. Ryan, p. 92. *Antiochiam vero urbem maximam, ultra quam credi potest firmissimam atque inexpugnabilem*, Stephen of Blois, *Letters*, RHC Oc 3, p. 888. Although Fulcher was not at the siege of Antioch, he visited the city only a couple years later.

[216] Fulcher of Chartres, *Historia Hierosolymitana* 1.15.1, ed. Hagenmeyer, pp. 215-17, trans. Ryan, p. 92; Albert of Aachen, *Historia Ierosolimitana* 3.36-38, ed. and trans. Edgington, pp. 196-201.

[217] *Gesta Francorum* 5.12-13, 8.18-19, ed. and trans. Hill, pp. 29-30, 39-43; Raymond of Aguilers, *Historia Francorum* 7-8, RHC Oc 3, pp. 247-50, trans. Hill and Hill, pp. 41-46; Stephen of Blois, *Letters*, RHC Oc 3, pp. 889-90; Anselm of Ribemont, *Letters*, RHC Oc 3, pp. 890-93; letter of the people of Lucca on crusade to all faithful Christians, trans. Krey, in *The First Crusade*, pp. 161-62; Robert the Monk, *Historia Iherosolimitana* 5.4, RHC Oc 3, pp. 793-94, trans. Sweetenham, p. 138. Robert the Monk states that the third fort was an old castle, rather than a monastery, which Tancred repaired. The cloistered layout of a monastery, intended to shut out the world, was a naturally defensible type of structure and monasteries were used as counterforts before and after the time of the First Crusade.

[218] For the siege of Antioch and the battle that followed, see France, *Victory in the East*, pp. 197-296.

Antioch: mural towers (from Rey)



Unlike at Nicaea, siege machines figured very little into the crusaders' siege of Antioch. It is simplistic to conclude that the ineffectiveness of the ballistic siege engines employed at Nicaea was the reason for their corresponding absence before the even stronger fortifications of Antioch; however, there is a degree of truth in this. According to Guibert of Nogent, all sorts of siege engines were of no use and, had the city not been betrayed, the Franks would have endured famine and other difficulties in vain.[219] Although descriptions of the siege of Antioch are far more substantial and detailed than those of Nicaea, references to artillery, or any siege machinery, are few. Eyewitness evidence suggests its possible employment at only two stages in the siege: during efforts to stem raids from the Bridge Gate and by the Franks defending the barrier built between Mt Silpius and the citadel after the city had fallen.[220]

A passage in the *Gesta* notes the latter incident. It states that *machinae*, presumably artillery, were employed to support the Frankish position in a defensive role.[221] Raymond of Aguilers notes the construction of *machinae* in connection with efforts to build a siege fort to control the Bridge Gate, although he calls the engines useless.[222] Anselm of Ribemont describes the construction of this fort in one of his letters and notes that *balistariae* were placed within; however, it is unclear what type of weapons these men were supposed to have been employing.[223] It is left to the far more detailed account of Albert of Aachen, who was not a participant of the crusade, to gain greater insight into these weapons.

Albert of Aachen claims that before Raymond of St Gilles attempted to obstruct the Bridge Gate, he tried to destroy the bridge outside of the Dog Gate. In the third attempt

[219] *Huic obsidendae quarumcumque machinarum balistarumve tormenta nil poterant*, Guibert of Nogent, *Die gesta per Francos* 6.16, ed. Huygens, p. 250, trans. Levine, p. 116.

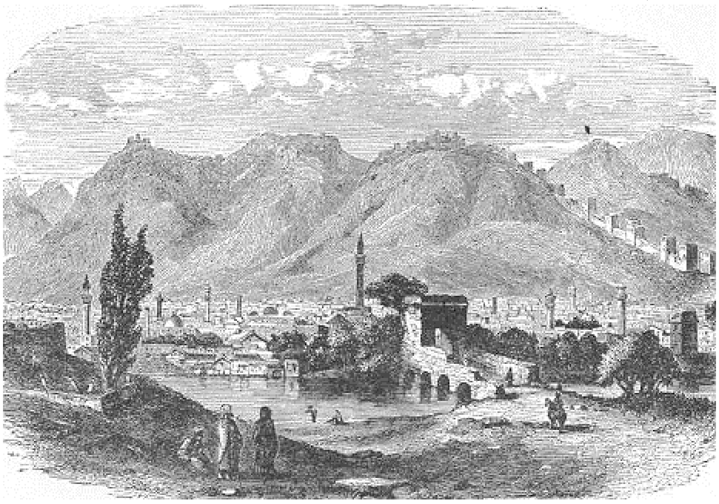
[220] The limited references to artillery probably reflect its limited impact against the impressive defences of Antioch and their defenders.

[221] *Gesta Francorum* 9.26, ed. and trans. Hill, p. 62.

[222] Raymond of Aguilers, *Historia Francorum* 7, RHC Oc 3, p. 248, trans. Hill and Hill, p. 41.

[223] Anselm of Ribemont, *Letters*, RHC Oc 3, pp. 890-93. It is possible that *balistaria* is meant to identify a machine rather than an operator; however, this is of no more help identifying the type of machine. The term was associated with engines as significant as a traction trebuchets or as light as a crossbows, depending on the source, in the eleventh century.

Antioch: Bridge Gate, from the west (from Whitney)



to break up the bridge, Albert states that the crusaders tried to use three *mangenae* to damage the gate beyond the bridge, as well as sections of adjacent curtain and forewall. The engines, however, failed to make any impression upon the defences. Although Albert suggests that these engines were meant to destroy fortifications, this artillery might instead have been used against the defenders, who employed their own *mangenae* and fired down on the Franks with arrows from the parapet. In any case, the Franks resorted instead to obstructing the bridge with felled trees and large stones.[224] It is noteworthy that in all three instances, artillery was apparently used to stem the egress of hostile defending forces.

For the defenders' use of artillery, it is again the writers who were absent who provide the most useful insights. In addition to engines that were used against Raymond's efforts to destroy the bridge outside of the Dog Gate, Albert of Aachen claims that *mangenae* were used to dispatch the heads of Adalbero of Metz and a female companion back to the Franks.[225] Fulcher of Chartres also claims that the Muslims threw the heads of fallen Franks back over the walls, using *petrariae* and *fundabula*, while Robert the Monk ascribes this practice to the Franks and their *balistae*.[226] Collectively, these accounts suggests that the artillery used at Antioch was comparable to that employed at Nicaea.

[224] Albert of Aachen, *Historia Ierosolimitana* 3.40-42, ed. and trans. Edgington, pp. 202-5. Cf. *Chanson d'Antioche* 147, trans. Edgington and Sweetenham, p. 182. Peter Tudebode describes the use of a penthouse, similar to that used in Raymond's second effort against the Dog Gate, to damage the Fortified Bridge outside of the Bridge Gate in spring 1098, although he mentions no artillery supporting it, Peter Tudebode, *Historia de Hierosolymitano Itinere* 8.1, RHC Oc 3, pp. 50-51. Neither of these episodes are found in the *Gesta*.
[225] Albert of Aachen, *Historia Ierosolimitana* 3.41, 46, ed. and trans. Edgington, pp. 202-3, 208-11.
[226] Fulcher of Chartres, *Historia Hierosolymitana* 1.15.10, ed. Hagenmeyer, p. 221, trans. Ryan, p. 94; Robert the Monk, *Historia Iherosolimitana* 4.3, RHC Oc 3, p. 777, trans. Sweetenham, p. 123. Similar to Fulcher's account, William of Malmesbury claims that the garrison used *ballistae* and *petrariae* to throw the heads of Christian Syrians and Armenians, slain within the city, into the Frankish camp, William of Malmesbury, *De gestis rerum Anglorum* 4.361, ed. Stubbs, 2:417, trans. Giles, pp. 379-80. Cf. *Chanson d'Antioche* 187, trans. Edgington and Sweetenham, p. 209; Michael Attaleiates, *History* 28.4.6, ed. and trans. Kaldellis and Krallis, pp. 414-15.

In contrast to the accounts of the siege of Nicaea, it is the rarity of the mention of artillery that is notable at Antioch. Neither the *Gesta* nor Ralph of Caen make any mention of artillery being used outside of the walls of Antioch and Fulcher of Chartres, who notes its use in defence, gives no indication that artillery was ever used by the Franks. Thomas Asbridge has suggested that the Franks lacked the materials or craftsmen to construct siege engines at Antioch;[227] however, such an argument seems improbable. The Franks built notable engines at the preceding siege of Nicaea and subsequent siege of Jerusalem, but at neither would they have had the body of skilled labour that passed through the nearby ports of Latakia and St Symeon while they were besieging Antioch. Furthermore, the material and skill to build three siege forts was evidently present. The apparently modest scale and simplicity of contemporary artillery would have posed few building challenges to any who had seen, much less operated, such an engine previously. Rather than a shortage of skill or materials, it seems that their brief experience at Nicaea had in fact impressed upon the Frankish forces the limitations of these engines before such extensive classical defences. As at Nicaea, artillery would appear to have been used in a supportive role at Antioch; but as this was a more passive siege, its impact was far less significant.

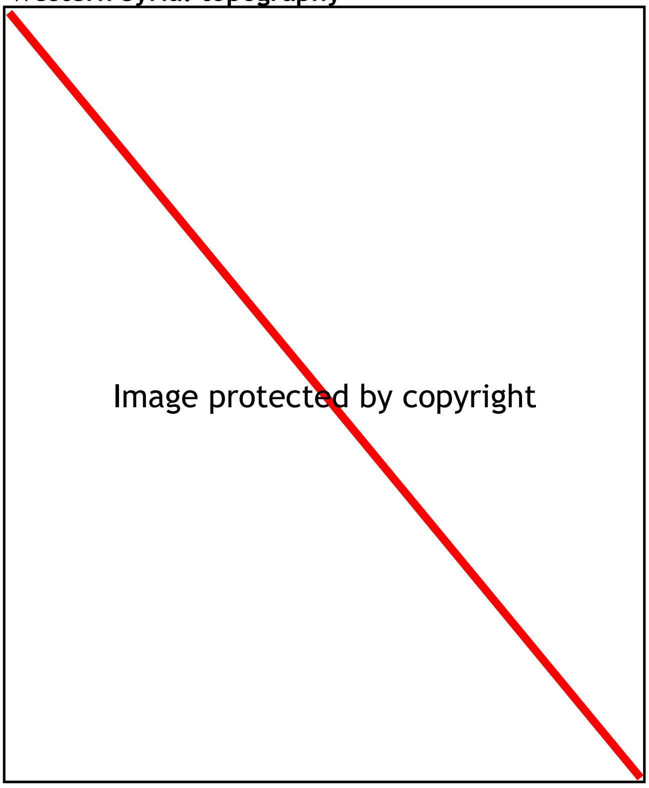
Marrat al-Nu'man and Arqa: 1098

Marrat al-Nu'man

The next significant siege of the First Crusade was that of Marrat al-Nu'man (Ma'arra).[228] On 27 November 1098, Raymond of St Gilles and Robert of Flanders encamped with a contingent of crusaders near the town's walls. An unsuccessful attempt was made to storm the town using ladders the following day and a second attempt failed a few days later, by which time Bohemond had arrived with a rival force.[229] A third assault was carried out on 11 December 1098. This time, making use of a mobile siege tower in addition to

[227] Asbridge, *The Crusades*, p. 66.
[228] The siege of Albara has been omitted on the basis that the sources offer little insight into the techniques that were employed and the general lack of details.
[229] Raymond of Aguilers, *Historia Francorum* 14, RHC Oc 3, p. 268, trans. Hill and Hill, pp. 75-76.

Western Syria: topography



ladders, the Franks appear to have gained a foothold on the parapet by nightfall and the town was pillaged the next day.[230]

Ralph of Caen, who was not present, appears to be the only source who claims that the Franks employed artillery at this siege.[231] The engines are portrayed as more powerful than in previous references but this appears to be a result of his poetic writing style. Although the Franks may not have employed artillery at Marrat al-Nu'man, its defenders did. Raymond of Aguilers, the *Gesta*, Guibert of Nogent, Ralph of Caen and Robert the Monk all note the defenders' use of at least one stone-thrower to target the Provençal siege tower.[232] The potential effectiveness of stones and Greek fire thrown by defensive artillery would become apparent by the end of the crusade.

230 *Gesta Francorum* 10.33, ed. and trans. Hill, pp. 78-79; Raymond of Aguilers, *Historia Francorum* 14, RHC Oc 3, pp. 268-70, trans. Hill and Hill, pp. 76-79; Guibert of Nogent, *Die gesta per Francos* 6.18, ed. Huygens, pp. 251-54, trans. Levine, pp. 116-17; Albert of Aachen, *Historia Ierosolimitana* 5.30, ed. and trans. Edgington, pp. 374-77; Ralph of Caen, *Gesta Tancredi* 104, RHC Oc 3, p. 679, trans. Bachrach and Bachrach, pp. 121-22; Fulcher of Chartres, *Historia Hierosolymitana* 1.24.3, ed. Hagenmeyer, p. 261, trans. Ryan, p. 113; Robert the Monk, *Historia Iherosolimitana* 8.5-7, RHC Oc 3, pp. 846-49, trans. Sweetenham, pp. 183-86; Ibn al-Qalanisi, *Dhail*, trans. Gibb, p. 46. Robert the Monk adds a battering ram to the equipment used by the Franks and Albert of Aachen specifies that the wood for the engines came from the castle of Talamria, which he had already acquired, in the Syrian mountains.

231 Ralph of Caen, *Gesta Tancredi* 96, 103-4, RHC Oc 3, pp. 674, 678-79, trans. Bachrach and Bachrach, pp. 115, 121-22. Cf. William of Tyre, *Chronicon* 7.9, ed. Huygens, 1:353-55, trans. Babcock and Krey, 1:310-12.

232 Raymond of Aguilers, *Historia Francorum* 14, RHC Oc 3, p. 269, trans. Hill and Hill, p. 78; *Gesta Francorum* 10.33, ed. and trans. Hill, p. 78; Guibert of Nogent, *Die gesta per Francos* 6.18, ed. Huygens, pp. 251-54, trans. Levine, pp. 116-17; Ralph of Caen, *Gesta Tancredi* 104, RHC Oc 3, p. 679, trans. Bachrach and Bachrach, pp. 121-22; Robert the Monk, *Historia Iherosolimitana* 8.5, RHC Oc 3, p. 846, trans. Sweetenham, p. 183.

Arqa

Arqa was an ancient city sited on a ridge extending northwards from Mt Lebanon, only a few kilometres from the coast and not much farther from Tripoli to the southwest.[233] Unlike the urban strongholds hitherto besieged by the Franks, Arqa's natural position offered no readily accessible line of approach. This denied any attacking force the option of using a siege tower.

When the siege opened on 14 February 1099, the only tactics available to the Franks were general assaults with ladders, made difficult by the sloping terrain, mining, which proved ineffective, and the use of ballistic engines. Accordingly, an artillery duel appears to have taken place and Anslem of Ribemont was among those who fell amid the exchange.[234] Ralph of Caen provides an interesting indication of the use of such machines when he states that the leaders, Robert of Normandy, Raymond of St Gilles and Tancred, built *tormenta* to use against the walls, which he claims was common practice, but also that each leader had his own.[235] The assertion that it was common practice to build such engines and the ability of each leader to build his own, appears to confirm that this technology was well known across Western Europe by the late eleventh century. Given Ralph's free style, however, it is possible that the practice to which he refers was a more general one of building siege engines. When compared with the accounts of his contemporaries, Ralph seems to exaggerate the power of the artillery and the degree of destruction inflicted at Arqa. The Frankish engines appear to have posed little threat, as, when mining proved difficult, the crusaders seem to have been quite content to accept a payoff when it was offered by the emir of Tripoli. The Franks resumed their march south in May 1099 and Arqa remained under Muslim rule for another ten years.

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233 William of Tyre, *Chronicon* 7.14, ed. Huygens, 1:360-61, trans. Babcock and Krey, 1:318.

234 Raymond of Aguilers, *Historia Francorum* 15-16, RHC Oc 3, pp. 275-78, trans. Hill and Hill, pp. 87-92; Ralph of Caen, *Gesta Tancredi* 105-10, RHC Oc 3, pp. 680-83, trans. Bachrach and Bachrach, pp. 123-27; Albert of Aachen, *Historia Ierosolimitana* 5.31-36, ed. and trans. Edgington, pp. 376-87; Fulcher of Chartres, *Historia Hierosolymitana* 1.25.1-3, ed. Hagenmeyer, pp. 265-67, trans. Ryan, p. 113; Guibert of Nogent, *Die gesta per Francos* 6.23, ed. Huygens, pp. 264-65, trans. Levine, p. 122; *Gesta Francorum* 10.34-35, ed. and trans. Hill, pp. 83-84. Cf. Ralph of Caen, *Gesta Tancredi* 106, RHC Oc 3, pp. 680-81, trans. Bachrach and Bachrach, p. 123.

235 Ralph of Caen, *Gesta Tancredi* 105, RHC Oc 3, p. 680, trans. Bachrach and Bachrach, p. 123.

Jerusalem: 1099

The conquest of Jerusalem appears to have been the accepted goal of the First Crusade by the time the various contingents set out across Europe; however, others also coveted the holy city. With the distraction caused by the Frankish presence in Syria, al-Afdal, vizier of Fatimid Egypt, besieged Jerusalem in July 1098, at that time under a Seljuk emir.[236] Both Ibn al-Qalanisi and the later account of Ibn al-Athir emphasise the use of artillery and claim that the city's fall was a direct result of the damage that it inflicted.[237] Although it is tempting to see these Muslim engines as superior to their Frankish counterparts, subsequent Muslim sieges suggest that this was not necessarily so.

Situated in the Judean hills, between the coastal plain and the Jordan Valley, the trace of Jerusalem's walls had changed over the centuries. By the time that the Franks arrived, the walls stretched 4 km along a line which roughly corresponds with the present Ottoman trace. The northern front of the city extended for almost 1.5 km and was naturally approachable, standing at a slightly lower elevation than the remainder of the plateau which extends farther north. The Roman defences along this line had been strengthened under Muslim rule with the addition of a forewall and rock-cut fosse.[238] The eastern side of the city, facing the Kidron Valley, was inaccessible to a sizeable force given the gradient of the topography. The western face was unapproachable along its southern half while the northern was anchored by two strong towers: the city's citadel, known as the Tower of David, in the centre of the western defences, and the Quadrangular Tower (Tancred's Tower or Tower of Goliath), which secured the northwest corner of the city.[239] To the south, there was a constricted approach opposite the Tanners' Gate, just

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[236] It is presumptuous to tie this attack directly to the fall of Antioch. The amount of time required to assemble the Fatimid forces of Egypt meant that this process likely started before the city fell, although news of this blow to the Abbasids no doubt encouraged their preparations and strengthened their resolve. Fatimid forces appear to have required about two months to assemble and then march to Ascalon around the start of the twelfth century, Hamblin, *The Fatimid Army*, pp. 180-85.

[237] Ibn al-Qalanisi, *Dhail*, trans. Gibb, p. 45; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:21. Even Albert of Aachen notes the use of artillery during the Fatimid siege of Jerusalem, though his source for this information is unknown, Albert of Aachen, *Historia Ierosolimitana* 6.31, ed. and trans. Edgington, pp. 442-43.

[238] For descriptions of the medieval defences of Jerusalem and excavation findings, see Boas, *Jerusalem*, pp. 46-49; Pringle, "Town Defences," pp. 80-81; Weksler-Bdolah, "The Fortification System"; Mazor, "The Northern City Wall of Jerusalem"; Reich and Shukron, "Excavations in the Mamillah Area"; Broschi and Gibson, "Excavations along the Western and Southern Walls"; Broschi, "Mount Zion," p. 285.

[239] For a contemporary description of the citadel, see Fulcher of Chartres, *Historia Hierosolymitana* 1.26.4, ed. Hagenmeyer, pp. 284-85, trans. Ryan, p. 117. Fulcher claims that the stones were fused with lead, a

Jerusalem: town and initial deployment of crusaders in 1099, plan and topography

west of the Temple Mount, or via the broader plateau, about 150 m square, that was the southern extension of Mt Zion. Both had been left exposed when the trace of the southern city walls had been redrawn under Muslim rule.[240] From the Frankish sources it appears that a ditch had been added along this front by 1099.

practice described by Vitruvius, Vitruvius, *De architectura*, 2.8.4, ed. Krohn, trans. Morgan, pp. 51-52. Cf. Boas, *Jerusalem*, pp. 66-75.

[240] Prawer has suggested this may have occurred during the latter half of the tenth century or following an earthquake around 1033, Prawer, "The Jerusalem the Crusaders Captured," p. 2. Boas and Pringle believe that the redrawing of the southern line took place in the eleventh century, Boas, *Jerusalem*, pp. 43-44; Pringle, "Town Defences", p. 79. During the Ayyubid period, Mount Zion was completely enclosed in an effort to strengthen this section of the southern front.

As the Franks approached Jerusalem, the population of the surrounding region sought refuge within the city. The garrison gathered supplies, equipment and whatever timber they could from the surrounding area, burning the rest and poisoning the region's wells.[241] The Christian population of Jerusalem was then expelled to eliminate the risk of a fifth column, as had been done at Antioch.

When the crusaders arrived on 7 June 1099, they immediately set about establishing a siege, dividing themselves into two groups. Robert of Normandy positioned himself near the church of St Stephen, opposing the St Stephen Gate (Damascus Gate) with Robert of Flanders to his right and Godfrey and Tancred stationed around the Quadrangular tower, thus covering the western half of the northern defences. Raymond of St Gilles initially opposed David's Gate (Jaffa Gate) but, given the restrictions of the terrain in this area, he soon repositioned his forces to the south, establishing them on Mt Zion near the church of St Mary of Mt Zion.[242] Although a more suitable position from which to assail the city, the restrictions of the plateau forced this group to encamp fairly close to the city's walls and may have placed them within range of the defending archers at all times.

On 13 June 1099, the Franks made their first assault. Although the northern force was able to gain the forewall, their efforts to take the main wall failed.[243] Following this test of the defenders' strength, it was agreed that machinery would be necessary to take the city, resulting in no less than two towers, artillery and a ram, in addition to a number of ladders.

The terminology used by the sources to describe the artillery used by and against the Franks is characteristically vague. The terms *machinae* and *mangenae* are used by Albert of Aachen to refer to the Franks' engines while Raymond of Aguilers adds

[241] Benvenisti estimates the population of Jerusalem may have swelled to 40,000 at this point, Benvenisti, *The Crusaders*, pp. 35-36.
[242] *Gesta Francorum* 10.37, ed. and trans. Hill, p. 87; Peter Tudebode, *Historia de Hierosolymitano Itinere* 14.1, RHC Oc 3, p. 102; Raymond of Aguilers, *Historia Francorum* 20, RHC Oc 3, pp. 292-93, trans. Hill and Hill, pp. 116-17; Albert of Aachen, *Historia Ierosolimitana* 5.46, ed. and trans. Edgington, pp. 402-5.
[243] *Gesta Francorum* 10.37, ed. and trans. Hill, p. 88; Raymond of Aguilers, *Historia Francorum* 20, RHC Oc 3, p. 293, trans. Hill and Hill, p. 117; Fulcher of Chartres, *Historia Hierosolymitana* 1.27.2, ed. Hagenmeyer, pp. 293-94, trans. Ryan, p. 119; Albert of Aachen, *Historia Ierosolimitana* 6.1, ed. and trans. Edgington, pp. 406-7; Ralph of Caen, *Gesta Tancredi* 118-119, RHC Oc 3, pp. 688-89, trans. Bachrach and Bachrach, pp. 134-36. Ralph of Caen gives a mystical account of Tancred receiving direction from a monk to attack the city on this day and his discovery of a cache of hidden lumber, which proved to be just enough for the single siege ladder. It is more likely that the Franks had multiple ladders, allowing them to take the forewall, but not enough of sufficient scale to take the main wall. The region's local timber is predominantly short and rarely straight – perhaps only one of the Frankish ladders was of sufficient height and strength to provide access to the parapet of the primary curtain.

tormenta and *petrariae* when identifying those used by the garrison.[244] Writing decades later, William of Tyre uses the terms *mangana* or *petrariae* and Roger of Wendover calls these machines *petrariae* and *trubuculi*.[245] None of the sources provide a detailed description. Nonetheless, the main challenge faced by the Franks when constructing their artillery, and much more so when erecting their siege towers, was the need for wood.

Finding tall and straight trees in the Judean hills would have been challenging even if the area was more fertile in the Middle Ages than it is now.[246] The Franks scoured the area as far as Nablus to find wood, possibly aided by the local Christians who had recently been evicted.[247] To this end, the Franks benefited from the timely arrival of a Genoese fleet at Jaffa on 17 June. Trapped in the harbour by Fatimid vessels, the Genoese party, under the Embriaco brothers, was escorted to Jerusalem by a party of crusaders.[248] Timber, which had been stripped from the ships, was also carried back to the siege. The long beams, oars and even the ships' fasteners may have been regarded as divinely delivered as the Genoese sailors helped the Provençal carpenters construct their siege engines.

As at Marrat al-Nu'man, the Franks oriented their strategy around siege towers. Godfrey undertook the construction of one tower on the northern side of the city, placing this under Gaston of Bearn, while Raymond of St Gilles built another on Mount Zion, placing this under William Ricau.[249] Constructed primarily from the wood taken from the Genoese vessels, Raymond's tower would have been as sturdy as the conditions

[244] Albert of Aachen, *Historia Ierosolimitana* 6.2, ed. and trans. Edgington, pp. 406-7; Raymond of Aguilers, *Historia Francorum* 20, RHC Oc 3, pp. 298-99, trans. Hill and Hill, pp. 125-26.
[245] William of Tyre, *Chronicon* 8.6, ed. Huygens, 1:392-93, trans. Babcock and Krey, 1:351; Roger of Wendover, *Flores historiarum*, ed. Coxe, 2:135, trans. Giles, 1:429.
[246] Adrian Boas has suggested that this may have been exacerbated by the series of sieges which had repeatedly consumed the surrounding timber over the preceding millennium, Boas, *Jerusalem*, pp. 5-7.
[247] Ralph of Caen, *Gesta Tancredi* 123, RHC Oc 3, p. 691, trans. Bachrach and Bachrach, p. 139; Peter Tudebode, *Historia de Hierosolymitano Itinere* 15.1-3, RHC Oc 3, pp. 106-7; Albert of Aachen, *Historia Ierosolimitana* 6.2-4, ed. and trans. Edgington, pp. 406-9; *Gesta Francorum* 10.38, ed. and trans. Hill, p. 90.
[248] Raymond of Aguilers, *Historia Francorum* 20, RHC Oc 3, pp. 294-95, trans. Hill and Hill, pp. 119-20; Caffaro, *De liberatione*, ed. Belgrano, p. 111, trans. Hall and Phillips, p. 117; Peter Tudebode, *Historia de Hierosolymitano Itinere* 14.1-2, RHC Oc 3, pp. 103-4; *Gesta Francorum* 10.37, ed. and trans. Hill, pp. 88-89; Caffaro, *De liberation*, ed. Belgrano, p. 110, trans. Hall and Philips, p. 116. Raymond adds that the tools which the Genoese brought proved invaluable in the construction of the southern siege tower, Raymond of Aguilers, *Historia Francorum* 20, RHC Oc 3, p. 298, trans. Hill and Hill, p.125.
[249] Raymond of Aguilers, *Historia Francorum* 20, RHC Oc 3, p. 297, trans. Hill and Hill, pp. 123-24; *Gesta Francorum* 10.37, ed. and trans. Hill, p. 88. Large parties of captured and coerced Muslim labourers may have taken part in handling the large beams, salvaged from the Genoese ships, which were used to construct the Provençal tower.

allowed.[250] Albert of Aachen states that the defenders employed fourteen *mangenae* against the Frankish siege towers: five to the north to target Godfrey's tower and nine arrayed against that of the Provençals.[251] These were used to throw both stones and Greek fire; the shortage of water that was afflicting the army also posed a serious threat to the crusaders' machines.[252] When the Franks had completed their siege towers and supporting artillery, as well as mantlets and ladders, the Franks set about coordinating an attack.

The defenders of Jerusalem had strengthened their fortifications across from the northern siege towers as best they could. They added timber defences and heightened their towers with wooden turrets to mitigate the elevation advantage enjoyed by the siege towers. This compelled the northern assailants to attempt a daring manoeuvre: moving their tower from its original position, near the Quadrangular Tower, about a kilometre to the east during the night of 9-10 July.[253] As it did not enjoy the structural strength of southern tower and its Genoese timber, the northerners were able to disassemble their tower and move it to its new location.[254] Although not an eyewitness to these events, Albert of Aachen states that Franks moved their *mangenae*, and accompanying piles of ammunition, along with the tower. Three of these engines were then erected ahead of the tower's new position.[255]

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[250] Apparently using William of Tyre's account, some have added the construction of a second northern tower, bringing the total to three siege towers, Bradbury, *The Medieval Siege*, p. 116; Benvenisti, *The Crusaders*, pp. 37-38; William of Tyre, *Chronicon* 8.12, ed. Huygens, 1:401-2, trans. Babcock and Krey, 1:560-61.

[251] Albert of Aachen, *Historia Ierosolimitana* 6.15, ed. and trans. Edgington, pp. 422-23. Ralph of Caen and Fulcher of Chartres also make it clear that a number of defensive engines were used to target the northern tower, Ralph of Caen, *Gesta Tancredi* 123, RHC Oc 3, p. 691, trans. Bachrach and Bachrach, p. 139; Fulcher of Chartres, *Historia Hierosolymitana* 1.27.6, ed. Hagenmeyer, p. 296, trans. Ryan, p. 120.

[252] Raymond of Aguilers, *Historia Francorum* 20, RHC Oc 3, pp. 293-94, trans. Hill and Hill, pp. 118-19; *Gesta Francorum* 10.37, ed. and trans. Hill, p. 89.

[253] *Gesta Francorum* 10.38, ed. and trans. Hill, p. 90; Raymond of Aguilers, *Historia Francorum* 20, RHC Oc 3, p. 298, trans. Hill and Hill, pp. 124-25; Fulcher of Chartres, *Historia Hierosolymitana* 1.27.5, ed. Hagenmeyer, pp. 295-96, trans. Ryan, p. 120; Peter Tudebode, *Historia de Hierosolymitano Itinere* 15.2, RHC Oc 3, pp. 107-8; Guibert of Nogent, *Die gesta per Francos* 7.6, ed. Huygens, pp. 275-78, trans. Levine, p. 128-29; Ralph of Caen, *Gesta Tancredi* 123, RHC Oc 3, p. 691, trans. Bachrach and Bachrach, p. 139; Albert of Aachen, *Historia Ierosolimitana* 6.9, ed. and trans. Edgington, pp. 414-15.

[254] It seems unlikely that the tower was designed so that it could be disassembled, as it took three days just to reassemble it once it was moved. Ralph of Caen claims that this manoeuvre was planned all along and the theory has since been supported by Thomas Asbridge, who suggests that the move took place on the night of July 13-14, rejecting the dating found in the *Gesta* and related sources, Asbridge, *The Crusades*, pp. 96-99. The ambiguous timing surrounding the construction of Robert of Normandy's tower at Courcy in January 1091, might suggest that such a tactic had been attempted before, Orderic Vitalis, *Historiae ecclesiasticae* 8.16, ed. Chibnall, 4:232-35.

[255] Albert of Aachen, *Historia Ierosolimitana* 6.9, ed. and trans. Edgington, pp. 414-15.

Supported by their artillery, the northern force of Franks used their ram to batter the forewall on 13-14 July.[256] The shaky siege tower was pushed up behind the ram and on Friday 15 July it was brought up against the main wall. In addition to denying the defenders along the rampart the protection of their battlements, the tower allowed the Franks to bridge the gap and gain access to the parapet. As the first Franks began stepping onto the walls, others were encouraged to bring up ladders and the northern defences were successfully stormed.[257] To the south, the Provençal contingent launched a corresponding attack.

Jerusalem: town and final deployment of crusaders in 1099, plan and topography

The southern force met stiff opposition from the defenders' artillery as they attempted to finish filling the fosse and advance their siege tower on 14 and 15 July. Unlike that built to the north, there was no room to manoeuvre the southern tower, leaving the defenders free to concentrate and then calibrate their artillery. The barrage had taken a toll on the sturdy tower by the time it was pushed forward on 15 July. Incendiaries were then thrown as it drew nearer. It seems these combustibles proved effective and the crippled tower was on the verge of being withdrawn when news arrived around noon that the northern contingents had broken into the city. Encouraged once more and with chaos consuming the town, they used ladders to force their way onto the parapet.[258] From about midday on 15 July 1099, Jerusalem was subject to a thorough and brutal sack.

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[256] Rams create fractures in the masonry ahead of them, crushing rather than puncturing. The fractures form seems, so most of the mass that is removed is extracted by men with picks and prybars, rather than being smashed out of place by the machine itself. Because such engines are extremely cumbersome, France has argued, building on Albert of Aachen's account, that the ram used by the northern Franks was burnt *in situ* to clear its bulk from the path of the approaching tower, France, *Victory in the East*, pp. 349-50.

[257] Albert of Aachen, *Historia Ierosolimitana* 6.9-12, 16-19, ed. and trans. Edgington, pp. 414-19, 422-29; Fulcher of Chartres, *Historia Hierosolymitana* 1.27.5-10, ed. Hagenmeyer, pp. 295-99, trans. Ryan, pp. 120-21; Ralph of Caen, *Gesta Tancredi* 124-27, RHC Oc 3, pp. 691-94, trans. Bachrach and Bachrach, pp. 139-43; Raymond of Aguilers, *Historia Francorum* 20, RHC Oc 3, pp. 299-300, trans. Hill and Hill, p. 127; *Gesta Francorum* 10.38, ed. and trans. Hill, pp. 90-92.

[258] Raymond of Aguilers, *Historia Francorum* 20, RHC Oc 3, pp. 298-99, trans. Hill and Hill, pp. 125-27; *Gesta Francorum* 10.38, ed. and trans. Hill, pp. 90-91; Peter Tudebode, *Historia de Hierosolymitano Itinere*

The Franks' Artillery

Artillery was an important tactical tool employed by both the attackers and defenders. As with previous sieges of the First Crusade, the best indications of its power are somewhat morbid. The most illustrative descriptions of the capabilities of such engines are associated with an episode related by Peter Tudebode and Albert of Aachen concerning the treatment of a Muslim spy:

> They took him, with bound hands and feet, and put him in the sling of a machine called a *petrera* and intending with all their strength to hurl him into the city, they were unable to do so. For with such force it happened that his bonds broke before he arrived at the wall of the city and he was dismembered.[259]
>
> After this and other reports the messenger was handed back to the soldiers, and he was put into the [*tormentum*] of one of the mangonels with hands and feet bound, so that he would be thrown over the walls after the first and second charge. But the skin of the mangonel [sling] was too heavily weighed down by the weight of his body and did not throw the wretch far. He soon fell onto sharp stones near the walls, broke his neck, his nerves and bones, and is reported to have died instantly.[260]

The machine described here is a traction trebuchet. The unfortunate spy was placed in the sling, which was attached to the end of the long arm of the beam, and the men pulling were hauling on the ropes attached to the end of the short arm. If the machine here was of the same dimensions as that which has been postulated may have been used against Nicaea, the prisoner, assigned a mass of 70 kg, would have been accelerated to such a limited velocity that he almost certainly would never have left the sling. However, if the axle is fitted to create a beam ratio of 2:1, decreasing mechanical advantage but increasing mechanical efficiency, and the downward pulling force is increased to represent close to 1,000 kg, it might be possible to accelerate the unfortunate projectile to around 18 m/s,

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15.3, RHC Oc 3, pp. 108-9; Fulcher of Chartres, *Historia Hierosolymitana* 1.27.7, 11, ed. Hagenmeyer, pp. 296-97, 299-300, trans. Ryan, pp. 120-21; Albert of Aachen, *Historia Ierosolimitana* 6.16-17, ed. and trans. Edgington, pp. 422-25. Raymond of Aguilers' account of the southern push is the most detailed but contains some conflicting information. For example he notes the existence of a forewall, which none of the other sources mention and for which there is no archaeological evidence. He also appears to suggest that the Provençal force built more than one siege tower; although possible, this is not corroborated by the other sources.

[259] This author's translation, *atque eum acceptum, ligatis manibus ac pedibus, posuerent eum in funda cuzusdam ingenii, quod petrera vocatur, atque cum omnibus viribus suis cogitantes eum projicere infra civitatem, nequiverunt. Nam cum tanto impetu venit, quod, ruptis vinculis, antequam ad murum pervenisset civitatis, dilaceratus est*. Peter Tudebode, *Historia de Hierosolymitano Itinere* 15.2, RHC Oc 3, p. 107.

[260] *Post hanc et ceteras relationes militibus restitutus, tormento cuiusdam mangene ligatis manibus et pedibus est inmissus ut sic post primam et secundam inundationem trans muros iataretur. Sed nimio corporis eius pondere pellis mangene grauata, non longe miserum proiecit. Qui mox iuxta muros corruens super asperos silices, fractis ceruicibus, neruis et ossibus, in momento extinctus fuisse refertur.* Albert of Aachen, *Historia Ierosolimitana* 6.14, ed. and trans. Edgington, pp. 422-23.

subjecting him to a flight of about 30 m if he was thrown at an initial trajectory of 45°. This range would be slightly extended if the projectile's flight ended below the horizontal plane of release, adding an additional 5 m of horizontal range if he landed at the base of a 6 m fosse for example.[261]

Given the limitations of traction power, throwing a mass this great, let alone of irregular size, is impractical. Testing carried out by modern reconstructions attempting to throw conglomerate masses of masonry have demonstrated the violence of the reciprocal centrifugal and centripetal forces that projectiles are subject to as they rapidly accelerate before release. These chunks of masonry are often torn apart through the firing sequence, ripping stone from mortar before the point of release.

There are no indications that the Franks employed counterweight trebuchets at Jerusalem and considering the limited supplies of suitable timber, and lack of any reference to wood brought from the Genoese ships being used to construct artillery, these engines do not appear to have been any stronger than those used at Nicaea or Antioch. Furthermore, their method of employment confirms that they were used as antipersonnel weapons.

Although Ralph of Caen and Albert of Aachen claim that sacks were hung from the walls to lessen the impact of the Frankish artillery, this tactic is more commonly used to protect siege towers from artillery and masonry fortifications from battering rams. In the account of Fulcher of Chartres, who like Ralph and Albert was not present at the siege, the Muslims tied two beams across the battlements as additional protection. The same beams then served as the bridge from Godfrey's tower to the wall in this version of events.[262] While these beams can be interpreted as fulfilling a similar purpose to the sacks found in the accounts of Ralph and Albert, they were as likely used as a type of improvised hoarding: rather than shielding the walls, they provided additional temporary cover for those men on the parapet.[263] By securing the beams over and in front of the merlons, the Muslims would have been able to protect themselves better from the Frankish artillery

[261] Froissart provides an account of a trebuchet being used successfully to throw an emissary back into Auberoche during the Hundred Years War, Froissart, *Chroniques* 1.1.218, ed. Luce, 3:65.

[262] Ralph of Caen, *Gesta Tancredi* 124-25, RHC Oc 3, pp. 692-93, trans. Bachrach and Bachrach, pp, 140-42; Albert of Aachen, *Historia Ierosolimitana* 6.17-19, ed. and trans. Edgington, pp. 424-29; Fulcher of Chartres, *Historia Hierosolymitana* 1.27.8, ed. Hagenmeyer, pp. 297-98, trans. Ryan, pp. 120-21.

[263] Unlike more developed hoarding or machicolations, these improvised measures would not likely have provided the means to assault those at the base of the walls, directly below the defenders.

and archers as well as those on top of the siege tower.[264] Decreasing the size of the crenels in this way would have left enough space to fire through, but the added protection came at the expense of restricting the vertical field of view. While this may appear to have been a significant weakness, most arrows and slung stones fired against those who approached the base of a walls would have come from flanking towers rather than the battlements above, where the defenders were more likely to drop stones, requiring minimal visibility to do so.

The Muslims' Artillery

Despite the emphasis that has been placed on the Frankish engines, the sources seem to agree that the defenders enjoyed an advantage in artillery. Retrospectively, William of Tyre judged the Muslims' machines to have been superior to those of the Franks because they were constructed from materials brought into Jerusalem ahead of the siege, supplemented with structural beams harvested from buildings within the city.[265] Raymond of Aguilers says these *tormenta* and *petrariae* outnumbered those of the Franks by nine or ten to one while Albert of Aachen gives the definitive figure of fourteen *mangenae*, nine of which were directed against the Provençal tower.[266] The incendiaries that were thrown by these engines at times were conglomerates of pitch, sulphur and other components, mixed to a consistency that would help them stick to the siege towers, or containers of combustibles that were provided with iron spikes to achieve the same end.[267]

Possibly reflecting the comparative strength of the southern siege tower, the defenders arrayed more artillery against it than against that to the north. From its prepared positions, the defending artillery was able to seriously cripple the stronger siege tower by the final stages of the siege. To the north, the defenders were forced to reposition their artillery when the Franks moved their siege tower and the focus of their assault eastward. The urban environment behind the walls may have posed challenges not only to moving

[264] This is all postulated. Fulcher did not arrive in Jerusalem until the following year so was not an eyewitness of the siege, although neither was Albert of Aachen, who never visited the East. The latter's account states that this timber was a large tree trunk, covered in combustibles, which the defenders attempted to use to burn Godfrey's tower, Albert of Aachen, *Historia Ierosolimitana* 6.18-19, ed. and trans. Edgington, pp. 426-29.
[265] William of Tyre, *Chronicon* 8.8, 13, ed. Huygens, 1:395-96, 403-4, trans. Babcock and Krey, 1:354, 361-63.
[266] Raymond of Aguilers, *Historia Francorum* 20, RHC Oc 3, p. 298, trans. Hill and Hill, p. 125; Albert of Aachen, *Historia Ierosolimitana* 6.15, ed. and trans. Edgington, pp. 422-23.
[267] Fulcher of Chartres, *Historia Hierosolymitana* 1.27.6, 9, ed. Hagenmeyer, pp. 296, 298-99, trans. Ryan, pp. 120-21; Raymond of Aguilers, *Historia Francorum* 20, RHC Oc 3, pp. 298-99, trans. Hill and Hill, pp. 125-26.

the defensive engines but also effectively firing them from their new location.[268] Albert of Aachen claims that the Muslims' artillery struggled to hit the siege tower as it advanced because there was not a sufficient open space between the buildings that would allow it to fire effectively. Each engine would have required an open area of space directly behind it equal to the length of the long arm of the beam plus that of the affixed sling, allowing the projectile to complete its arcing pre-release flight path uninterrupted. As the tower neared the wall and gained its protection, projectiles had to be released at increasingly high trajectories with decreasing accuracy.[269] Despite these difficulties, enough fire was brought to bear against the northern tower to reveal its structural weakness. Devoid of the more sturdy beams brought by the Genoese from Jaffa, the tower was leaning to one side by the time it reached the northern wall.

The stone-throwers employed throughout the First Crusade were almost certainly traction trebuchets.[270] Although the conduct of the Franks at Jerusalem is commonly portrayed as the result of a two-year learning experience, this is a drastic over simplification.[271] The individuals involved would have sharpened their martial skills over time, but this is true of any extended campaign. While some of its leaders gained more experience than they had previously gathered in Europe, the tactics employed by the Franks at each siege were the product of pre-existing European traditions and not new methods learned through the course of their travels. The artillery that they employed was of a known and familiar type. It continued to be used as a supporting weapon, in an antipersonnel capacity, while mining was the most effective breaching tactic. Although rarely acknowledged, the most effective and decisive siege weapon employed by the crusaders was the ladder.

The Franks possessed neither a superior tradition in arms nor technology and the artillery used by the Franks appears to have been fairly similar in both capability and form to that of their Muslim adversaries. Rather than any tactical or technological advantage, the most significant advantage that the crusaders enjoyed through this episode was the determination of the rank and file and unity of their purpose. The goal of Jerusalem and

[268] Albert of Aachen, *Historia Ierosolimitana* 6.17, ed. and trans. Edgington, pp. 424-25. Ralph of Caen also notes this redeployment, Ralph of Caen, *Gesta Tancredi* 123, RHC Oc 3, p. 691, trans. Bachrach and Bachrach, p. 139.
[269] For an examination of this practice, see Chapter 5. See also Chapter 9.
[270] Most of those who suggest otherwise are not well acquainted with the broader study of artillery, as their focus lies elsewhere, for example, Asbridge, *The First Crusade*, pp. 55, 127; Kostick, *The Siege of Jerusalem*, pp. 82-83.
[271] For example, Rogers, *Latin Siege Warfare*, p. 87. Cf. France, *Victory in the East*, p. 370.

the promised grace that its liberation offered was enough to inspire many who otherwise inexplicably endured the hardships associated with the march from Europe to Palestine and months of gruelling siege conditions. It was these individuals who were largely responsible for the labour which went into constructing the Frankish war machines and less glorious tasks associated with their function.

4. Artillery in the Twelfth Century

Limitations (1099-1187)

The Opening Decades

Following the sieges of the First Crusade, artillery was used both offensively and defensively throughout the twelfth century. In the opening decades, there are fewer comprehensive Frankish sources for the campaigns launched in northern Syria than there are to the south in Palestine. This produces a skewed image of where and how artillery was employed. Although there is anecdotal evidence that artillery was used by the Frankish lords of Antioch and Tripoli, it is more frequently mentioned during sieges undertaken by the forces of Jerusalem. Even when analysing events in Palestine, there are certain issues when dealing with the written sources and little archaeological evidence against which to evaluate their testimony.

The closest Frankish source to events in Palestine during the early twelfth century was Fulcher of Chartres, chaplain of Baldwin I of Jerusalem. He repeatedly states that his chronicle was written to give a true and accurate account of events surrounding the Franks in the Holy Land, but it is not as complete as might be desired, having undergone as many as three redactions, and, like the similar narratives composed by his contemporaries, is in part a work of propaganda. Although he lived in Jerusalem from late 1100, Fulcher maintained an interest in affairs to the north throughout the remainder of his life. While Fulcher appears to have made use of the *Gesta* and Raymond of Aguilers' account before composing his account of the First Crusade, he relies on his own knowledge and information obtained from others around him when composing the subsequent portion of his work.[272] The account of Albert of Aachen is, according to Susan Edgington, "the most

[272] For a discussion of Fulcher of Chartres, his sources and work, see Fulcher of Chartres, *Historia Hierosolymitana*, trans. Ryan, pp. 3-56, esp. pp. 42-46.

complete, most detailed, and most colourful of the contemporary narratives of the First Crusade and the careers of the first generation of Latin settlers in Outremer (1095-1119)." Albert's account was written independent of any knowledge of contemporary accounts. Although he never visited the East himself, he appears to have relied primarily on the oral testimony of those who had been on crusade, rendering his account detailed but suspect.[273] Although writing much later in the twelfth century and in a deliberately classical style, William of Tyre made use of the accounts of both Fulcher and Albert when composing his account of the events of the early twelfth century. Given his position in the Church and later role as Chancellor of the kingdom of Jerusalem, he probably had access to many other sources to supplement the works of his predecessors.[274] While all three wrote with a slightly different audience in mind, each may have hoped that their work would inspire Europeans to take up the cross and help defend Latin control of the Holy Land.

From the Muslim perspective, the work of Ibn al-Qalanisi, a high-ranking Damascene civil servant, is of paramount importance up to the author's death in 1160. The nature of his position provided an ideal perspective from which to compose a chronicle of events from first-hand knowledge of pertinent documents and oral testimony.[275] In the same year that Ibn al-Qalanisi died, another great Muslim historian, Ibn al-Athir, was born. Ibn al-Athir made extensive use of the histories written before his own time, including that of Ibn al-Qalanisi, to compile a more complete, if more distant, history of events, written mainly from Mosul. Ibn al-Athir does not appear to have held a high administrative or bureaucratic post, but was patronised by the Zangids, towards whom his work is slightly partial.[276]

The sources for this period and those that follow must each be considered independently. Few of these authors who were eyewitnesses to the sieges that they describe and would have had little direct knowledge of contemporary artillery. However, each would have been familiar with the concept of mechanical artillery, both from earlier writings to which they had access and from oral descriptions of contemporary engines provided by those more acquainted with siege warfare. Both would inevitably have

[273] For a discussion of Albert of Aachen, his sources and work, see Albert of Aachen, *Historia Ierosolimitana*, ed. and trans. Edgington, pp. xxi-xxxvii.
[274] For a discussion of William of Tyre, his sources and work, see Edbury and Rowe, *William of Tyre*, pp. 13-58.
[275] For a discussion of Ibn al-Qalanisi, his sources and work, see Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 8-14.
[276] For a discussion of Ibn al-Athir, his sources and work, see Ibn al-Athir, *al-Kamil*, trans. Richards, 1:1-5.

influenced their portrayal of these engines. Given this imprecision, it will be highlighted when certain sources were eyewitnesses to described events. Inevitably, there are issues of reliability, exaggeration and bias with any documentary source, but until sources become more numerous later in the period, little can be done but to evaluate how each source treats artillery.[277]

The Palestinian Coast

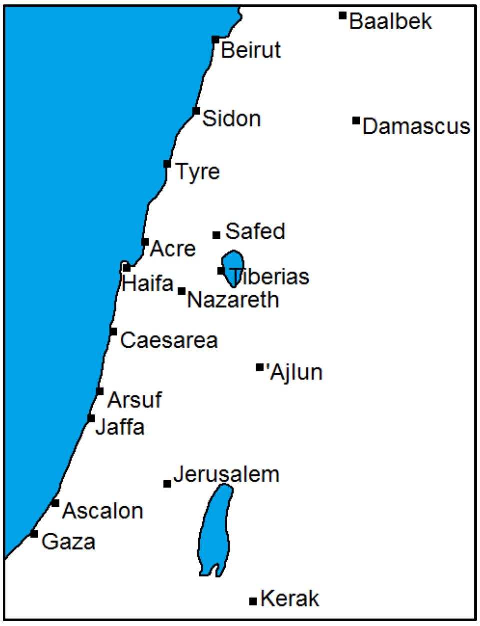
The initial thrust of Frankish expansion in Palestine was across Galilee and along the Mediterranean coast. The sieges of these coastal towns received the most descriptive contemporary accounts and provide the clearest insight into Frankish artillery during this period of expansion. Albert of Aachen states that Godfrey of Bouillon spent six weeks constructing *mangenae* and other siege engines during the siege of Arsuf in 1099.[278] Despite the presence of two siege towers, the attack failed.[279] The following year, Albert asserts that seven *mangenae* were used to support a siege tower built during the Veneto-Frankish assault on Haifa led by Tancred.[280] Godfrey's successor, Baldwin I of Jerusalem, renewed efforts against Arsuf in 1101, this time with Genoese assistance. The town surrendered very quickly, despite Fulcher of Chartres' account of a Frankish siege tower collapsing under the weight of its occupants. Artillery is not even summarily mentioned by the sources at this siege.[281] After Arsuf had been garrisoned, the Franks turned on Caesarea, less than 40 km to the north.

At Caesarea, efforts once more focused on the construction of a siege tower. This was built from the masts and oars of ships and it is tempting to suggest that prepared timbers were also used to construct the *petrariae* that were used to protect the tower. After fifteen days of bombardment, and with their siege tower still incomplete, a general assault was launched with ladders. The zeal of the Franks and apparent effectiveness of their artillery, which Fulcher of Chartres claims was able to damage the parapet, allowed the

[277] Visual sources have a similar set of issues. For a complimentary examination of illustrative sources, see Appendix 1.
[278] Albert of Aachen, *Historia Ierosolimitana* 7.1-5, ed. and trans. Edgington, pp. 486-93.
[279] This failure is often attributed to the absence of Italian naval assistance, a point emphasised by William of Tyre the better part of a century later, William of Tyre, *Chronicon* 9.19, ed. Huygens, 1:446, trans. Babcock and Krey, 1:409-10. For an analysis of the Fatimid fleet at this time, see Hamblin, "The Fatimid Navy," pp. 77-83.
[280] Albert of Aachen, *Historia Ierosolimitana* 7.22-25, ed. and trans. Edgington, pp. 516-21.
[281] See Albert of Aachen, *Historia Ierosolimitana* 7.54, ed. and trans. Edgington, pp. 562-63; Fulcher of Chartres, *Historia Hierosolymitana* 2.8, ed. Hagenmeyer, pp. 395-400, trans. Ryan, pp. 151-53; Caffaro, *Annales*, ed. Belgrano, p. 9, trans. Hall and Philips, p. 53; William of Tyre, *Chronicon* 10.13 (14), ed. Huygens, 1:468-69, trans. Babcock and Krey, 1:433-35.

Franks to storm the town.[282] The location of this damage suggests that the Frankish artillery was either targeting the battlements or the defenders behind them. Although these engines probably posed little threat to the city's defences, they appear to have been sufficiently powerful to have left an impression on the soft *kurkar* sandstone used in their construction.[283] The amount of energy capable of producing such an effect would also have been sufficient to damage most improvised defences that might have been set up along the parapet, similar to those used at Jerusalem in 1099. It is likely to have been reports of this superficial damage that so impressed Fulcher, who was probably based in Jerusalem at this time.

Palestine



Baldwin I's attentions next turned to Acre. The city had been besieged unsuccessfully by his brother Godfrey in 1100,[284] and Baldwin himself failed before its walls in 1103.[285] Fulcher of Chartres, followed by William of Tyre, notes that the latter attempt was a brief siege, confined mainly to burning the surrounding gardens. Albert of Aachen, however, gives a more sensational account, which includes the mention of a siege tower and *mangenae* during a five-week siege that brought the Franks to the verge of success before a Muslim relief force arrived by sea.

When Baldwin moved against Acre in May 1104, he did so with the aid of a Genoese fleet. After the city had been assaulted for around twenty days, again with the assistance of siege engines, the defenders were compelled to seek terms of surrender.[286]

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[282] Fulcher of Chartres, *Historia Hierosolymitana* 2.9, ed. Hagenmeyer, pp. 400-4, trans. Ryan, pp. 153-55; Albert of Aachen, *Historia Ierosolimitana* 7.55-56, ed. and trans. Edgington, pp. 564-67; Caffaro, *Annales*, ed. Belgrano, pp. 9-12, trans. Hall and Phillips, pp. 53-56; William of Malmesbury, *De gestis rerum Anglorum* 4.380, ed. Stubbs, 2:444-45, trans. Giles, pp. 405-6; William of Tyre, *Chronicon* 10.14 (15), ed. Huygens, trans. Babcock and Krey, 1:435-37. For less detailed Muslim perspectives, see Ibn al-Qalanisi, *Dhail*, trans. Gibb, p. 51; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:47-48.
[283] Cf. the siege of Arsuf (1265) in Chapter 7.
[284] Ibn al-Qalanisi, *Dhail*, trans. Gibb, p. 51; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:47.
[285] Fulcher of Chartres, *Historia Hierosolymitana* 2.22, ed. Hagenmeyer, pp. 456-57, trans. Ryan, pp. 174-75; William of Tyre, *Chronicon* 10.25 (26), ed. Huygens, 1:485, trans. Babcock and Krey, 1:453; Albert of Aachen, *Historia Ierosolimitana* 9.19, ed. and trans. Edgington, pp. 660-61. William of Tyre asserts that the failure of the siege of Acre in 1103 was due to a lack of naval support.
[286] Fulcher of Chartres, *Historia Hierosolymitana* 2.25.1, ed. Hagenmeyer, pp. 462-63, trans. Ryan, p. 176; Albert of Aachen, *Historia Ierosolimitana* 9.27, ed. and trans. Edgington, pp. 670-71; Caffaro, *Annales*, ed. Belgrano, p. 14, trans. Hall and Phillips, p. 57; Caffaro, *De liberatione*, ed. Belgrano, pp. 121-22, trans.

William of Tyre stresses the ingenuity of the Frankish artillery that was placed around the city and seems to imply that artillery was mounted on top of the Franks' siege towers, when he says that large stones were thrown from them. If stone-throwing engines were positioned on top of these siege towers, the size of these machines would have been restricted. There is evidence that swing-beam artillery was used in this way, possibly at Breval in 1092 and at Durazzo in 1081;[287] however, accounts of large stones being thrown from the tops of siege towers are common and in most cases the apparent trajectory of these stones would suggest that they were tossed by hand.

Although the details found in William of Tyre's later account may add certain embellishments to the earlier accounts upon which this part of his chronicle is based, they are nevertheless important in confirming the tactical objectives and capability of these engines. Descriptions of damage done to the crenellations and buildings behind the defensive curtain reinforce the notion that the battlements of the city were targeted by the Franks' stone-throwers. Accordingly, literal readings of more colourful assertions, which have led some historians to conclude that these engines "destroyed the city walls and buildings within", are entirely unfounded.[288]

Artillery remained an important weapon as the Franks entered the second decade of their tenure in the East. Albert of Aachen notes the use of artillery by Bertrand of Toulouse against Tripoli in 1109, a piece of information corroborated by Ibn al-Qalanisi but absent from the account of Fulcher of Chartres.[289] Albert states that the Franks also used artillery against both Beirut and Sidon in 1110 and at the drawn-out, and eventually unsuccessful, siege of Tyre in 1111-12. Writing later, William of Tyre includes stone-throwing machines in his account of the siege of Beirut while the contemporary Muslim authority, Ibn al-Qalanisi, followed by Ibn al-Athir, notes their use against Tyre. Artillery

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Hall and Phillips, p. 123; William of Tyre, *Chronicon* 10.27 (28), ed. Huygens, 1:486-87, trans. Babcock and Krey, 1:454-56; Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 61-62. Ibn al-Athir does not mention any siege equipment at this siege, Ibn al-Athir, *al-Kamil*, trans. Richards, 1:78-79.

[287] Orderic Vitalis, *Historiae ecclesiasticae* 8.24, ed. and trans. Chibnall, 4:288-89; Anna Comnena, *Alexiad* 4.1, trans. Sewter, p. 135.

[288] This quote is from Benvenisti, *The Crusaders*, p. 81; however, the practice of taking such enthusiastic testimony literally is endemic.

[289] Albert of Aachen, *Historia Ierosolimitana* 11.11, ed. and trans. Edgington, pp. 782-83; Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 88-90; Fulcher of Chartres, *Historia Hierosolymitana* 2.40-41, ed. Hagenmeyer, pp. 526-33, trans. Ryan, pp. 193-96. See also Caffaro, *De liberatione*, ed. Belgrano, p. 123, trans. Hall and Phillips, pp. 123-24; Caffaro, *Annales*, ed. Belgrano, p. 14, trans. Hall and Phillips, p. 57. Tripoli had been blockaded to some degree since 1102, originally by Raymond of St Gilles and then his nephew William Jordan, before Bertrand arrived.

was also used defensively by the defenders of Beirut, according to Ibn al-Qalanisi, and the defenders of Sidon and Tyre, according to Albert of Aachen.[290]

Although artillery was frequently used by the Franks against the cities of coastal Palestine during the first decade of the twelfth century, the principal siege weapon used at many of these sieges was the siege tower. Artillery was used in a secondary role, supporting these towers, and this is why it is frequently mentioned but given little more than a nominal notice on most occasions. However, the repeated use of such engines is notable: indicating that the value of these machines justified the time, cost and manpower required to construct and operate them.

The North

Evidence for the use of artillery in northern Syria is more obscure; for instance, no such machines are mentioned in Ralph of Caen's otherwise detailed account of Tancred's siege of Latakia.[291] As in Palestine, Albert of Aachen notes the presence of artillery at more sieges than any other contemporary source during the first quarter of the twelfth century. He mentions its use at Apamea in 1106 and al-Atharib in 1110 and specifies that twelve *mangenae* were used against Vetula (Qal'at Bani Qahtan) in 1111.[292] Although it is possible that artillery was used at certain sieges, despite not being mentioned by most sources, the terrain of northern and western Syria also favoured a more mobile form of warfare. Siege tactics had to be more flexible when confronting the generally smaller and more topographically isolated strongholds of these regions.

Unlike the early set-piece sieges undertaken against the urban centres of coastal Palestine, most of the successful sieges in Syria at this time were concluded by a rapid escalade, or a quick surrender in the face of the imminent threat of such. By comparison, the gentle topography around the towns of the Palestinian littoral made them much more approachable and the greater circumference of their town walls meant that they were

[290] For Beirut, Albert of Aachen, *Historia Ierosolimitana* 11.15-16, ed. and trans. Edgington, pp. 788-89; William of Tyre, *Chronicon* 11.13, ed. Huygens, 1:515, trans. Babcock and Krey, 1:484-86; Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 99-100. For Sidon, Albert of Aachen, *Historia Ierosolimitana* 11.31-34, ed. and trans. Edgington, pp. 804-9. For Tyre, Albert of Aachen, *Historia Ierosolimitana* 12.6, ed. and trans. Edgington, pp. 830-33; Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 122-23; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:157. Only Albert of Aachen mentions artillery at the siege of Sidon in 1108, Albert of Aachen, *Historia Ierosolimitana* 10.46-51, ed. and trans. Edgington, pp. 760-67.

[291] Ralph of Caen, *Gesta Tancredi* 144, RHC Oc 3, pp. 706-9, trans. Bachrach and Bachrach, pp. 159-63.

[292] Albert of Aachen, *Historia Ierosolimitana* 10.20-21, 11.44-47, ed. and trans. Edgington, pp. 738-39, 820-25. For Apamea, cf. Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 69-70; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:92-93. For al-Atharib, cf. Matthew of Edessa, *Patmowt'iwn*, trans. Dostourian, p. 206; Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 105-6; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:153.

reliant on much larger bodies of fighting men to defend them. Whereas these conditions encouraged the use of siege towers and supporting artillery, the smaller more isolated strongholds of Syria were less susceptible to such tactics and instead encouraged massed frontal assaults or more passive blockades. The major urban centres of this region, with more extensive and approachable defences, including Aleppo, Hama and Homs, were not subject to an earnest siege by the Franks during this period. Thus the apparent absence of artillery from most sieges north of Palestine at this time probably reflects the rougher terrain and smaller population centres that were invested as much as the disparity of source material. But the Franks were not the only ones using artillery offensively.

Jaffa: 1123

The sieges of the First Crusade reveal that the Muslims of Syria-Palestine were as familiar with artillery as were their Frankish opponents. The only Latin reference to Muslims employing these engines during the first decade of the twelfth century is found in Albert of Aachen's account of an attack on Castellum Arnaldi, a small castle commanding the main western approach to Jerusalem through the Judean hills.[293] From the Muslim perspective, artillery is noted by Ibn al-Qalanisi during the siege of rebellious Baalbek by Tughtakin of Damascus in March-April 1110.[294] Few details are provided concerning the Damascenes' siege engines or how they were used before an amicable surrender was arranged, thirty-five days after the siege had begun.

In May 1123, Fatimid forces from Ascalon took advantage of Baldwin I's captivity to make an assault on Jaffa. What is particularly interesting about this episode is that Fulcher of Chartres claims that the attackers brought their artillery with them to Jaffa. The implication that these machines were prefabricated, along with Fulcher's claim that they threw sizable stones, appears to suggest that these were significant engines. However, both Fulcher's tendency to stress the power of artillery and the relatively small size of even 'large' projectiles at this time should be taken into consideration. Furthermore, a close reading of Fulcher's account reveals that these *tormenta* were used in a familiar manner: to target the battlements of Jaffa and more generally to apply pressure, both

[293] Albert of Aachen, *Historia Ierosolimitana* 10.14, ed. and trans. Edgington, pp. 730-33. This castle was rebuilt in 1132-33 by the patriarch of Jerusalem, William of Tyre, *Chronicon* 14.8, ed. Huygens, 2:639-40, trans. Babcock and Krey, 2:58. See also Pringle, *Secular Buildings*, no. 231, pp. 106-7; Pringle, "Templar Castles between Jaffa and Jerusalem," pp. 103-8.

[294] Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 96-98.

physically and psychologically, to the besieged.[295] Fulcher checks any notion that these were exceptionally large engines when he states that after five days of bombardment the walls had sustained minimal damage and that most was inflicted along the battlements. Finally, Fulcher's claim that these engines could fire from beyond the range of the garrison's archers seems to be an exaggeration, intended more to emphasise their impressive range than to give an accurate definition of it. Testimony from other sieges, such as the siege of Acre in 1189-91, directly contradicts this notion, as – so it appears – does surviving illustrative evidence.[296] The range of modern reconstructed traction trebuchets has also proved to be significantly less than the 200 m range of the most impressive medieval archers.[297]

It is only when Fulcher notes the approach of the Frankish relief force that the real thrust of the Egyptian assault on Jaffa becomes clear. Under partial cover of their artillery, Fatimid sappers were undermining the town walls. Unable to open a breach that would have allowed them to overwhelm the relatively small garrison before relief arrived, the Egyptians were compelled to dismantle their engines and evacuate them with the army to their ships. Despite Fulcher's apparent confirmation of the value of these engines, having been withdrawn rather than abandoned, it is the threat posed by the Fatimid miners that William of Tyre emphasises in his later account of this siege, omitting any mention of artillery.[298]

Tyre: 1124

In 1124 the Franks launched what was probably their largest siege operation since the First Crusade. Apart from Ascalon, Tyre was at this point the only remaining Muslim-held outpost on the Palestinian coast. The ancient Phoenician stronghold was surrounded by the sea and joined to the mainland by a shallow tombolo, which was enlarged during

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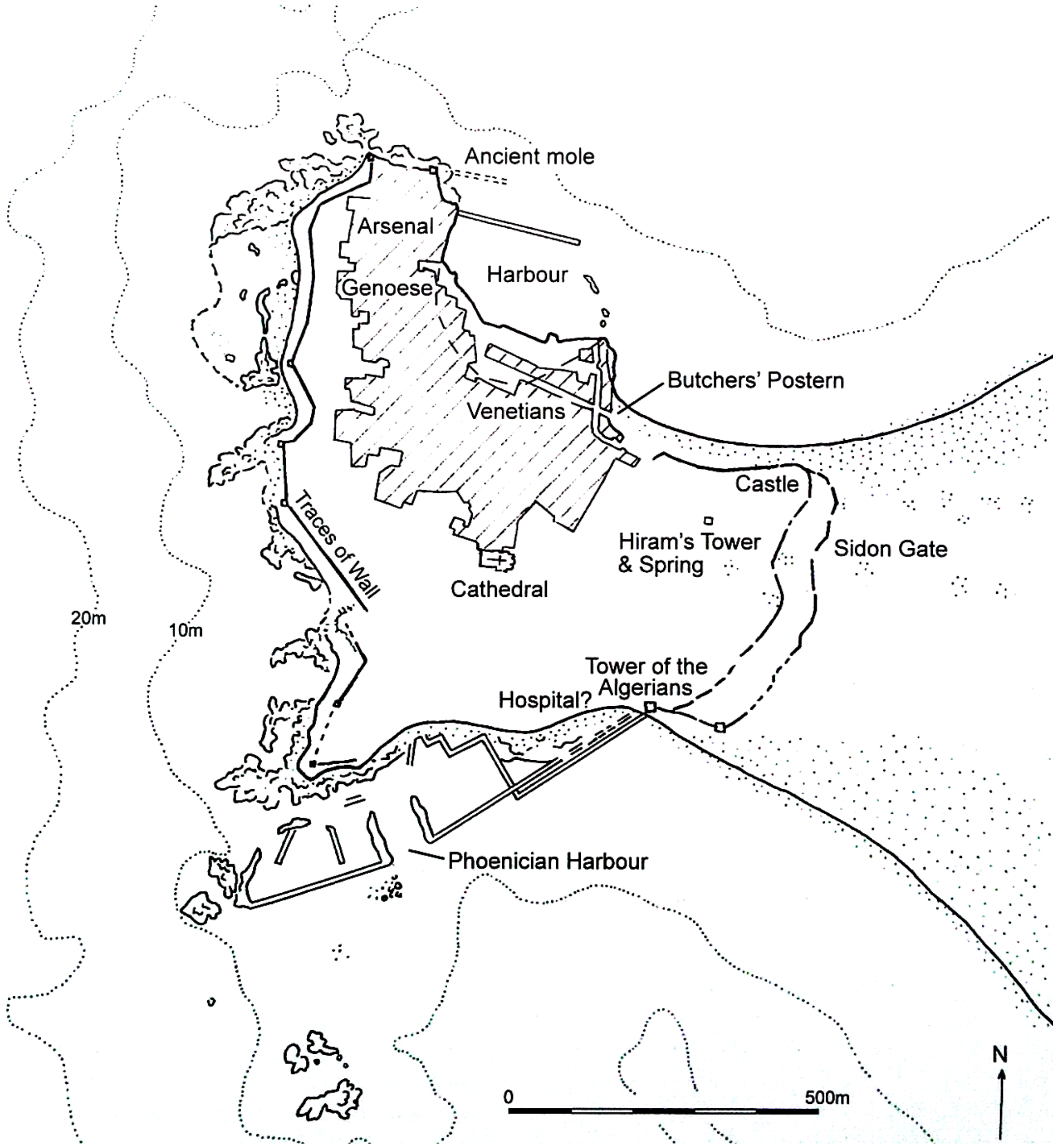
[295] Fulcher of Chartres, *Historia Hierosolymitana* 3.17, ed. Hagenmeyer, pp. 661-63, trans. Ryan, pp. 240-41. See also *Historia Nicaena* 80, RHC Oc 5, p. 184. Cf. Ibn Muyassar, *Akhbar Misr*, RHC Or 3, p. 469.
[296] See **Figs. B3**, **B4**, **B12** and **B19**. For the siege of Acre, see Chapter 5.
[297] See Appendix 4.
[298] William of Tyre, *Chronicon* 12.21, ed. Huygens, 1:572-73, trans. Babcock and Krey, 1:545-47. The assault is also found in the account of Ibn Muyassar who states that the Fatimids had hoped for Abbasid support, they withdrew when it was not forthcoming, Ibn Muyassar, *Akhbar Misr*, RHC Or 3, p. 469.

Tyre: town, plan (from Pringle)



Alexander the Great's famous siege in 332 BC.[299] A millennium and a half later, the proverbial strength of the city was still emphasised by those who visited.[300] The impetus for the siege in 1124 was the arrival of a Venetian fleet. The Venetians obviously intended to undertake a siege while in the Holy Land as Fulcher of Chartres states that they had brought long timbers with them, specifically those that were well suited for building siege engines.[301] This is the only cargo that Fulcher notes and, apart from the number of ships

[299] Marriner, Morhange and Meulé, "Holocene morphogenesis," pp. 9,218-23.
[300] For example, William of Tyre, *Chronicon* 22.30 (29), ed. Huygens, 2:1057, trans. Babcock and Krey, 2:501; Ibn Jubayr, *Rihla*, trans. Broadhurst, pp. 319-20. See also Anna Comnena, *Alexiad* 14.2, trans. Sewter, p. 442; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:328. For the medieval defences of Tyre, see Chapter 5.
[301] Fulcher of Chartres, *Historia Hierosolymitana* 3.14, ed. Hagenmeyer, pp. 655-57, trans. Ryan, p. 238-39; William of Tyre, *Chronicon* 13.6, ed. Huygens, 1:593, trans. Babcock and Krey, 2:10. See also *Historia Nicaena* 80, RHC Oc 5, p. 185.

that composed the fleet, the only real detail that he highlights about this force upon its arrival.

Under the leadership of the patriarch of Jerusalem and the doge of Venice, Tyre was invested from mid-February 1124. The Franks attempted to establish a blockade, digging two lines of trenches around the east end of the isthmus, cutting off the besieged and providing protection from hostile field forces, while all but one of the Venetian ships were pulled up on shore.[302] Carpenters then used the materials brought by the Venetians, and probably harvested additional timber from one or more of the beached vessels, to build siege towers and other engines.[303]

Various terms are used by the sources to identify the Frankish artillery. Fulcher of Chartres ambiguously notes the construction of *machinae* at the start of the siege.[304] A half-century after these events, William of Tyre specifies that some of these were *machinae iaculatoriae*, which could throw large stones against the town's walls and towers and terrorise the townspeople, while these are rendered as *perrieres* and *mangoniaux* in the subsequent *Eracles* translation.[305] Although this may appear to represent the creative licence of later sources, many Syriac sources also specify that artillery was built by the Franks to support their siege towers.[306] The garrison also employed artillery.

William of Tyre claims that the hail of defensive fire, from both artillery within the city and archers along the battlements, made it perilous for those guarding the Frankish siege towers and those moving to join or relieve the attackers within them.[307] Although there were still dangers faced by those inside, it would appear that the defenders' artillery was unable to threaten the immediate structural integrity of the siege towers. The strength of the Frankish engines would appear to have been comparable.

[302] William of Tyre, *Chronicon* 13.4, 6, ed. Huygens, 1:590, 593-94, trans. Babcock and Krey, 2:7, 10; *Anonymous Syriac Chronicle*, trans. Tritton, pp. 94-95.

[303] The rough February seas would have made beaching the fleet necessary; however, a significant part of it was launched later in the siege, restricting the amount of timber that the Franks could have harvested from these vessels.

[304] Fulcher of Chartres, *Historia Hierosolymitana* 3.31.1, ed. Hagenmeyer, pp. 721-23, trans. Ryan, p. 262.

[305] *Machinas nichilominus iaculatorias fabricari precipit, quibus magnis molaribus turres et menia concutiantur et civibus terror inferatur.* William of Tyre, *Chronicon* 13.6, ed. Huygens, 1:593, trans. Babcock and Krey, 2:10; *Eracles* 13.6, ed. RHC Oc 1, p. 563.

[306] Matthew of Edessa, *Patmowt'iwn*, trans. Dostourian, pp. 233-34; *Anonymous Syriac Chronicle*, trans. Tritton, p. 95. Cf. Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 170-72; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:252-53.

[307] William of Tyre, *Chronicon* 13.6, ed. Huygens, 1:593-94, trans. Babcock and Krey, 2:10-11.

Although William of Tyre claims that the Frankish artillery threw 'huge' projectiles and that the walls and towers of Tyre were nearly demolished by their barrage, his reference to numerous shots passing over the walls and damaging buildings within the city suggest that it was the parapet that was targeted. Similar allusions to impressive power but also the concentration of fire at the level of the parapet are found throughout both Fulcher of Chartres' and William of Tyre's accounts of various sieges. But had these engines posed a serious threat to fortified masonry, there would have been had little need to target the parapet. Instead, a more productive breach could be opened if lower sections of wall were targeted. Despite William of Tyre's colourful imagery of dust clouds created by the ferocity of the Frankish barrage, there is little evidence to suggest that engines as implicitly powerful as this were used even a half century later when William was writing his account of events. A certain episode during the siege further confuses matters.

At one point in the siege, Fulcher of Chartres notes that the defenders mounted a raid against the most formidable of the Franks' machines, successfully burning it. Fulcher describes this engine as having been used to "shatter the towers and the city walls by hurling rocks and riddling the defences with holes."[308] Although no medieval swing-beam siege engine was ever capable of firing cleanly through defensive masonry, this suggests that the projectiles of the besieging artillery may have been thrown hard enough to leave an impression upon impact, as seems to have been the case at Caesarea in 1101. This particular episode becomes more confusing when set against William of Tyre's account of a very similar sally, which again led to the burning of a notable Frankish engine. William does not state what type of machine was targeted by the party of defenders but his implication that the siege towers were their main objective makes it more likely that he considered it to have been one of the towers that was set alight rather than a trebuchet.[309] Unlike Fulcher, William states that the fire was extinguished and that the party responsible for setting the fire was apprehended and killed, leaving it entirely possible that the two sources are describing separate events.

Havedic

The climax of the siege in William of Tyre's account involves a certain character known as Havedic. William states that a particular stone-thrower of the defenders was wreaking

[308] *...qua solebant turres antea iactis lapidibus conquassari et vehementissime perforari.* Fulcher of Chartres, *Historia Hierosolymitana* 3.32.1-2, ed. Hagenmeyer, pp. 728-30, trans. Ryan, pp. 264-65.
[309] William of Tyre, *Chronicon* 13.10, ed. Huygens, 1:597, trans. Babcock and Krey, 2:15.

havoc on the Frankish siege towers. Despite noting earlier that experts were manning the Frankish artillery, William claims that no one in the Frankish camp was sufficiently skilled to destroy this menacing engine with one of their own stone-throwers. Accordingly, an Armenian expert, Havedic, was summoned from Antioch and then paid from the public treasury upon his arrival. The Franks apparently succeeded in targeting the defensive engine with Havedic's help, though William provides no more details.[310]

Havedic and the events surrounding him at Tyre are found only in William of Tyre's account of the siege.[311] Fulcher's silence is particularly notable as he was most likely living and writing in Jerusalem at this point in time.[312] Many historians have lent their interpretations to the events surrounding Havedic's presence at Tyre, despite the absence of a corroborative account.[313] Among them, Ronnie Ellenblum has argued that this may represent the first use of a counterweight trebuchet by Frankish forces.[314] Similarly, Paul Chevedden suggests that the Armenian introduced Byzantine gravity-powered artillery technology to the siege.[315] However, there is little evidence to suggest that any one of the machines employed at Tyre was more significant, powerful, or sizable than those used elsewhere by the Franks previously or that any Frankish engine was significantly more impressive than those of the defenders. Although it is entirely possible that there was experimentation with small counterweight trebuchets by 1124, it cannot be concluded with certainty that Havedic was brought to Tyre to construct such an engine.

Firstly, any suggestion that a small counterweight trebuchet is more difficult to construct than a traction trebuchet of similar size is baseless: additional skill is only required when the components become too large to be moved by hand. Secondly, there are few benefits to employing a small counterweight trebuchet. Although such an engine might produce slightly more power than a traction trebuchet of comparable size, it will suffer from a much lower rate of fire. It is this trade-off that ensured that the traction trebuchet remained in use long after large counterweight trebuchets were developed. But regardless of size, the counterweight trebuchet was an accurate engine provided the

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310 William of Tyre, *Chronicon* 13.10, ed. Huygens, 1:597-98, trans. Babcock and Krey, 2:15-16.
311 Babcock and Krey suggested that William's specificity alone makes his account of this episode credible, William of Tyre, trans. Babcock and Krey, 2:16 n. 23.
312 Fulcher of Chartres, *Historia Hierosolymitana* 3.34.5, ed. Hagenmeyer, p. 736, trans. Ryan, p. 267.
313 For the figure of Havedic (Awétik) and the context, see Dédéyan, *Les Arméniens*, pp. 462-3, 513, 536, 861-63.
314 Ellenblum, *Crusader Castles*, p. 210.
315 Chevedden, "Invention," p. 92. This appears to clash with Chevedden's own theory that such engines had already been used by the Franks at Nicaea in 1097, Chevedden, "Invention," pp. 76-79.

components and masses involved were not altered. Numerous small adjustments could be made, such as changing the length of the sling or angle of the release finger, to adjust an engine's range without altering the primary components. This allowed subsequent shots to be walked in or out relatively easily. Finally, if increasing accuracy was the reason for summoning an expert, it is more likely that the machines being employed were traction trebuchets. Traction models require teams pulling in a single synchronised motion to replicate the same force with each shot. Range can be adjusted by altering the amount of pulling force that the team applies to each shot or by attempting to maintain a constant amount of pulling force and altering the length of the sling or angle of the release finger. In either case, honing in on and maintaining a specific range is much more difficult. As William of Tyre does not state that Havedic constructed any kind of engine upon his arrival, let alone one with a new type of power source, it remains just as likely that if an artillery expert was summoned it was done to manage the artillery crews or adjust their traction trebuchets. Regardless of these details, it was the blockade that compelled the garrison of Tyre to sue for peace. On 7 July, in an anti-climactic end, the garrison of Tyre marched out and Frankish forces took control of the city after a five-month siege.[316]

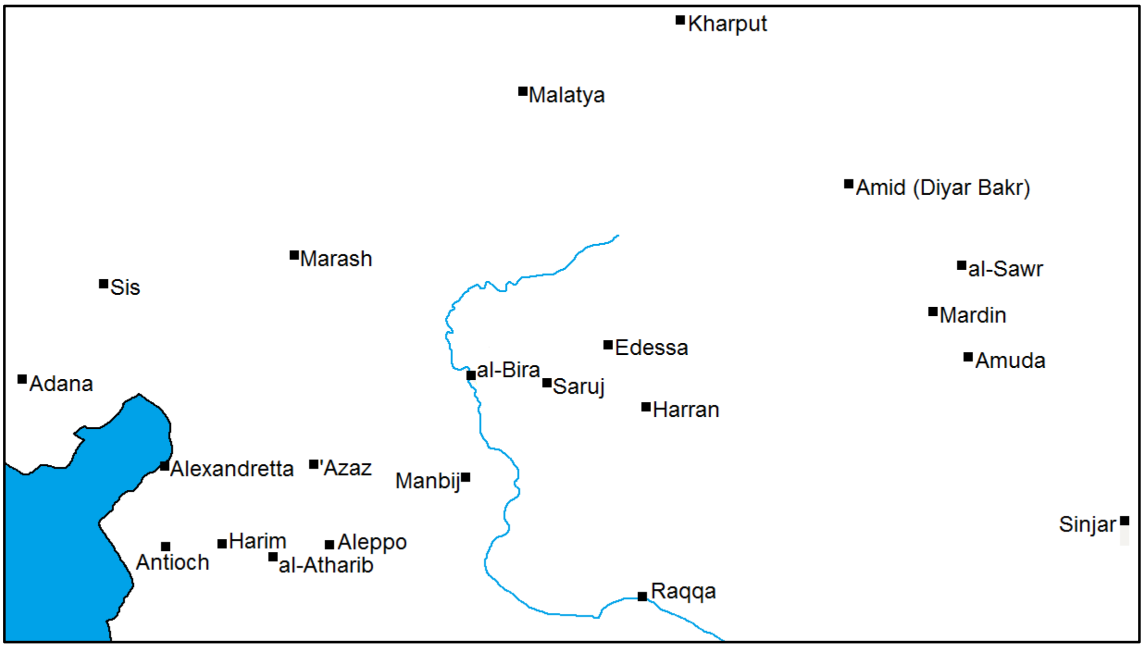
Offensives of Zanki and John Comnenus

To the north, most references to artillery during the 1120s are found in Matthew of Edessa's chronicle. Among them, Matthew includes the employment of stone-throwers at Balak's siege of Kharput in 1122, after its Frankish prisoners had taken control of the castle, as well as his siege of Muslim-held Manbij in 1124. Although the Syriac sources, notably Michael the Syrian, Bar Hebraeus and the *Anonymous Syriac Chronicle*, claim that it was artillery rather than mining that compelled the Franks to surrender Kharput, neither the Frankish sources nor their Muslim counterparts mention artillery at either siege.[317] Matthew also notes artillery at Bursuqi's siege of 'Azaz in 1225; this is

[316] Fulcher of Chartres, *Historia Hierosolymitana* 3.34.1-3, ed. Hagenmeyer, pp. 733-35, trans. Ryan, p. 266; William of Tyre, *Chronicon* 13.13-14, ed. Huygens, 1:600-2, trans. Babcock and Krey, 2:18-21; Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 170-72; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:252-53.

[317] For Kharput, Matthew of Edessa, *Patmowt'iwn*, trans. Dostourian, pp. 229-30; Michael the Syrian, *Chronicon* 15.13, trans. Chabot, 3:211-12; Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 1:251; *Anonymous Syriac Chronicle*, trans. Tritton, p. 93. See also Fulcher of Chartres, *Historia Hierosolymitana*

Northern Syria



corroborated by Fulcher of Chartres, William of Tyre and the *Anonymous Syriac Chronicle* but omitted by the Muslim sources.[318] Matthew specifies that twelve engines were used against 'Azaz but that the breaches that were opened in the walls, also noticed by Ibn al-Qalanisi, were brought about by mining. Despite the number of sources that take notice of artillery at these sieges, none of them provides any clear indications of the strength or power source of any of these engines. But when considered in relation to instances of Fatimid-employed artillery, such as at the defence of Jerusalem (1099), Beirut (1110), Sidon (1110) and Tyre (1111-12) and assaults on Castellum Arnaldi (1106/7) and Jaffa (1123), as well as the apparent use of artillery by Tughtakin of Damascus against Baalbek (1110), the rulers of Mosul were far from the only Muslims

3.23-26.2, ed. Hagenmeyer, pp. 676-91, trans. Ryan, pp. 246-54; Ibn al-Qalanisi, *Dhail*, trans. Gibb, p. 169; Kamal al-Din, *Bughyat*, RHC Or 3, p. 637; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:244; William of Tyre, *Chronicon* 12.18, ed. Huygens, 1:568, trans. Babcock and Krey, 1:541-44. Cf. Orderic Vitalis, *Historiae ecclesiasticae* 11.26, ed. and trans. Chibnall, 6:110-25. For Manbij, Matthew of Edessa, *Patmowt'iwn*, trans. Dostourian, pp. 231-32; Fulcher of Chartres, *Historia Hierosolymitana* 3.31, ed. Hagenmeyer, pp. 721-29, trans. Ryan, pp. 262-64. See also Kamal al-Din, *Bughyat*, RHC Or 3, pp. 641-42; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:251.

[318] Matthew of Edessa, *Patmowt'iwn*, trans. Dostourian, pp. 234-36; Fulcher of Chartres, *Historia Hierosolymitana* 3.42.5-11, ed. Hagenmeyer, pp. 763-67, trans. Ryan, pp. 277-79; William of Tyre, *Chronicon* 13.16, ed. Huygens, 1:604-6, trans. Babcock and Krey, 2:25; *Anonymous Syriac Chronicle*, trans. Tritton, p. 97. See also Ibn al-Athir, *al-Kamil*, trans. Richards, 1:258. Ibn al-Qalanisi appears mistaken when placing the assault on 'Azaz with the events of AH 517 (1123-24), an understandable error given the similarities in circumstance between Balak's assault on Manbij in 1124 and al-Bursuqi's assault on 'Azaz in 1125, Ibn al-Qalanisi, *Dhail*, trans. Gibb, p. 170. Chevedden has argued that counterweight trebuchets were used at 'Azaz, pointing to the mention of *manganiqe rawrbe* (great mangonels) by the later *Anonymous Syriac Chronicle* as evidence of such, Chevedden, "Invention," p. 92.

in greater Syria making use of stone-throwing engines in the first quarter of the twelfth century.[319]

Al-Sawr: 1134

One of the best insights into the potential power of Muslim artillery in the early twelfth century can be found in the eyewitness account of Zanki's siege of al-Sawr (Savur) by the warrior poet, Usama ibn Munqidh.

> Zanki then set up the mangonels against the citadel, which took down one side of it. But not enough of it was brought down for the men to use the breach to get up into the citadel. However, one of the atabeg's bodyguards, a man from Aleppo called Ibn al-'Ariq, climbed up through the breach and set to striking the enemy with his sword. But they injured him with a number of wounds and threw him down from the tower into the moat. By then, our men had overwhelmed them at that breach and we took possession of the citadel. The representatives of the atabeg climbed up to the citadel and took possession of its keys, sending them to Timurtash [ibn Ilghazi of Mardin], and granting Zanki the citadel.[320]

It seems reasonable to assume that the breach mentioned was made in the parapet rather than the bulk of the wall; this would explain why it was still difficult to exploit, hardly assailable by more than one man at a time as a degree of climbing was still necessary, but sufficient to provide access to the rampart. Although the citadel fell to a broader general assault, using the breach to access the parapet, Usama's indication that some form of surrender took place, evident with the transference of keys, implies that the assault was perhaps less overwhelming than the description implies.[321] An entirely different set of events a few years later provides another insight.

Montferrand: 1137

Zanki laid siege to Homs in May 1137. Failing to make progress, he cut his losses after a few weeks and moved on to invest the Frankish castle of Montferrand from early June.[322]

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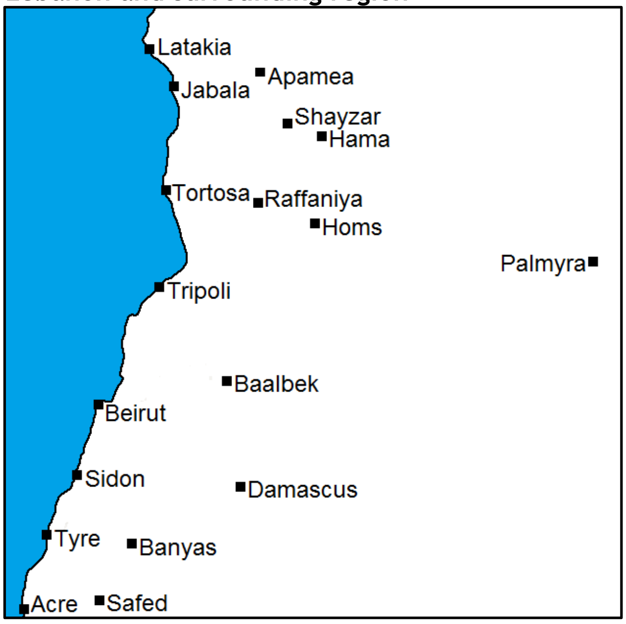
[319] See Appendix 2.

[320] Usama ibn Munqidh, *Kitab al-I'tibar*, trans. Cobb, p. 168. Cf. Ibn al-Athir, *al-Kamil*, trans. Richards, 1:306. Cobb locates Sur on the banks of the Khabur in the region of Diyar Bakr, n. 275.

[321] It is interesting that Zanki opted for an attack focussed on escalade, supported by artillery, as Usama mentions the presence of forces from Khursan, a virtual pseudonym for miners. For this convention see Usama's accounts of the sieges of Kafartab in 1115 and Masurra in 1132, and Ibn al-Qalanisi's accounts of the sieges of Banyas in 1132 and Edessa in 1144, Usama ibn Munqidh, *Kitab al-I'tibar*, trans. Cobb, pp. 85-87, 171; Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 216-17, 267. See also Prouteau, "Beneath the Battle," pp. 105-17.

[322] Homs was then an ally of his opponents in Damascus, Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 237-38; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:325-25.

Lebanon and surrounding region



In the heights overlooking Raffaniya, Montferrand was a bastion of Frankish influence near Homs and Hama and was described by Ibn al-Athir as "one of the Franks' strongest and most impregnable castles."[323] Zanki had previously besieged Pons of Tripoli in the castle unsuccessfully in 1133,[324] and in 1137 Fulk of Jerusalem and Raymond II of Tripoli found themselves commanding the castle's defence after an attempt to break the siege failed and the relief party was forced to take refuge with the besieged.

Because of the rugged strength of the castle's position, Zanki pitched his main siege camp in the plains bellow Montferrand, assigning the task of assaulting the castle to the emirs of his army in turn.[325] Usama describes the siege as a fairly lax endeavour, pressed without vigour by the emirs who faced it.[326] Kamal al-Din and the later accounts of Ibn 'Abd al-Zahir and Ibn al-Furat suggest that the siege was pushed quite hard, emphasising Zanki's use of mangonels, ten according to Kamal al-Din or fourteen according to the later sources.[327] William of Tyre seems to support this latter interpretation:

> Zangi continued his vigorous attacks upon the besieged with unremitting zeal. The very walls shook under the impulse of his mighty engines. Millstones [or large stones] and huge rocks hurled from the machines fell into the midst of the citadel, shattered the houses within, and caused intense fear to the refugees there.[328]

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[323] Ibn al-Athir, *al-Kamil*, trans. Richards, 1:336.
[324] William of Tyre, *Chronicon* 14.6, ed. Huygens, 2:637-38, trans. Babcock and Krey, 2:56; Ibn al-Qalanisi, *Dhail*, trans. Gibb, p. 221-22; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:303.
[325] Usama ibn Munqidh, *Kitab al-I'tibar*, trans. Cobb, p. 169.
[326] The rotating emirs possibly judged their individual prospects of taking the stronghold on the day that they opposed it, and the plunder which would accompany its fall, as too slight to risk the commitment of resources a real attempt would require. The castle was also well defended: when the relief force joined the garrison, the castle's provisions would have been consumed at a much more rapid rate but the combined defending force would have been capable of launching powerful sorties.
[327] Kamal al-Din, *Bughyat*, RHC Or 3, p. 673; Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:652; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:115.
[328] *Sanguinus interea, obsessos continuis urgens molestiis, menia tormentis quatiens, machinis molares et saxa ingentia iaculatoriis in medium contorquens presidium, domos prosternit interius non sine multa*

The phrases that William uses to describe the destruction are part of an established trend: drawing attention to any damage done within the enceinte and the psychological impact of the barrage as much as the damage sustained by the defences. Although it might be suggested that non-military sources, such as William of Tyre, might overemphasise any damage inflicted on non-military structures, these, and even non-combatants, could have been targeted with the objective of weakening the defenders' moral. While Zanki besieged the isolated castle of Montferrat, Byzantine forces concurrently besieged Antioch.

Antioch: 1137

At the culmination of a rapid campaign, which saw John Comnenus take Tarsus and the other fortified towns and castles of Cilicia that had become part of the principality of Antioch, the Byzantine army pushed into Syria and besieged Antioch in 1137.[329] William of Tyre claims that "Mighty machines and engines were placed in strategic positions around the city and ever-increasing pressure was exerted upon the place."[330] Although William suggests that this was an aggressively prosecuted siege, unlike the comparatively passive efforts of the Franks forty years earlier, Ibn al-Qalanisi instead characterises this as a blockade.[331] Alternatively, Niketas Choniates claims that John was travelling with artillery but was welcomed into Antioch while Vahram does not mention Byzantines ever moving out of Cilicia.[332]

Circumstances surrounding this siege bring into question William of Tyre's characterisation of it. Fulk's choice to continue to Montferrand rather than move to relieve Antioch and the decision, let alone ability, of Raymond of Poitiers, prince-regent of Antioch, to leave his besieged city to assist Fulk's relief effort, and then slip back into Antioch afterwards, are telling. But even if William overstates the tempo of the siege of

inclusorum formidine. William of Tyre, *Chronicon* 14.28, ed. Huygens, 2:667, trans. Babcock and Krey, 2:89.

329 This accumulation of territory in Cilicia was the primary objective of the Byzantine campaign, Vahram, *Chronicle*, trans. Neumann, pp. 31-32; Matthew of Edessa, *Patmowt'iwn*, trans. Dostourian, pp. 241-42; Niketas Choniates, *Historia*, trans. Magoulias, pp. 12-18. Antioch, which had not been returned to the Byzantines following its capture by the Franks in 1098, passed to Raymond of Poitiers, son of William IX of Aquitaine, in 1136 when he married Constance, daughter of the late Bohemond II and Alice of Jerusalem.

330 *Ordinatis itaque per girum machinis, et ingentibus tormentis congruis stationibus collocatis, urbem vehementius cepit artare.* William of Tyre, *Chronicon* 14.24, ed. Huygens, 2:663, trans. Babcock and Krey, 2:85.

331 Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 240-41.

332 Niketas Choniates, *Historia*, trans. Magoulias, pp. 16, 18; Vahram, *Chronicle*, trans. Neumann, pp. 31-32.

Antioch, his emphasis on the Byzantines' use of artillery should not be dismissed without consideration.

> The emperor, for his part, caused immensely heavy rocks to be hurled from the mighty machines and engines. In this way, he sought to weaken and break down the defences of the city and to shatter the walls and towers of the gate of the Bridge. Aided by a strong band of slingers, they sought at long range to prevent the townspeople from defending the walls and were ever on the watch for an opportunity to approach and undermine the fortifications.[333]

Like many of William's descriptions of artillery, this passage is in itself inconsistent. If artillery was sufficient to break down the defences of Antioch, why did these remain effectively defended, let alone require sappers to undermine them? When considering the topography, William's account may have been influenced by those of the First Crusade: the Bridge Gate was one of only a few areas where artillery may have been used in 1097-98.[334] Any hopes of discerning an accurate sense of this siege are dashed if an attempt is made to reconcile this with the less detailed but drastically differing accounts of other sources.[335]

Shayzar: 1138

After peace was established between Raymond of Poitiers and John Comnenus, there seems little doubt that the Byzantines unleashed the full might of their artillery at the subsequent siege of Shayzar in 1138. The citadel of Shayzar sits on a river-cut spur that rises from the left bank of the Orontes, overlooking the town to the west. The Greeks positioned their camp on the west side of the river and surrounded the town.[336] Ibn al-Athir state that the Byzantines employed eighteen stone-throwers against Shayzar.[337] Al-

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[333] *...imperator quoque versa vice tormentis ingentibus et machinis iaculatoriis, cautes inmanissimos, et inmensi ponderis contorquendo, a Porta Pontis menia cedendo et turres, urbis claustra debilitare et effringere nitebatur. Dispositisque per gyrum legionibus, sagittis, et omni missilium genere, necnon et fundibulariorum manu proterva, cives a muri propugnatione arcebant eminus; et ad suffodienda moenia aditum et opportunitatem nitebantur vendicare*. William of Tyre, *Chronicon* 14.30, ed. Huygens, 2:670, trans. Babcock and Krey, 2:92.

[334] See Chapter 3.

[335] Cf. Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 240-41; Michael the Syrian, *Chronicon* 16.8, trans. Charbot, 3:245; Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 1:264; Niketas Choniates, *Historia*, trans. Magoulias, pp. 14-16.

[336] For the defences of Shayzar, see Tonghini and Montevecchi, "The Castle of Shayzar: Access System," pp. 201-24; Tonghini and Montevecchi, "The Castle of Shayzar: Recent Archaeological Investigations," pp. 137-50; Tonghini, "Die Burg Saizar," pp. 234-40; Kennedy, *Crusader Castles*, p. 181; Müller-Wiener, *Castles of the Crusaders, p.* 55. See also Ibn al-Athir, *al-Kamil*, trans. Richards, 2:87-89.

[337] Ibn al-Athir, *al-Kamil*, trans. Richards, 1:340.

Kamil gives the same number of mangonels and adds that four *la'ab* (lighter engines) were also erected.[338] From the description provided by William of Tyre it must have seemed as though hell was unleashed upon the town:

> From the machines, set up in strategic positions, poured forth constant volleys of heavy stones which shook the towers and walls and even the houses of the people within. Under the repeated blows of these enormous missiles, the fortifications, on which the inhabitants had relied as their greatest defence, were utterly overthrown and in their fall wrought dreadful havoc among the townspeople.[339]

This rhetoric suggests a greater degree of destruction than most of William's earlier descriptions of artillery damage. It is possible that the Byzantines employed more powerful engines than most of those employed by their Frankish and Muslim neighbours or even that William was inspired to characterise them as such given the prestige of their Roman heritage. The source that he made use of is unknown. From a Greek perspective, Niketas Choniates, who was also born after the events in question, states that although the Byzantine artillery was able to open breaches in the defences of Shayzar, its fortifications remained entirely defensible.[340]

William of Tyre states that John Comnenus walked among his troops, admonishing those who worked the engines to take better aim and increase their rate of fire.[341] Although the evidence is far from conclusive, such encouragement would have been more useful to teams working traction trebuchets than larger counterweight engines. It is almost impossible for experienced operators to speed up any component of the loading processes of the latter, from waiting for the beam to come to a natural state of rest to the steady hauling or winching back of the arm into a cocked position, while the consistent firing motion of such engines makes them naturally accurate. On the other hand, the operation of a traction trebuchet is reliant entirely on close teamwork: synchronicity and consistency are both required to maintain a close measure of accuracy and rate of fire. Furthermore, if William of Tyre is implying that the artillery teams were

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338 Kamal al-Din, *Bughyat*, RHC Or 3, pp. 677-78. This source states that the Byzantines bombarded Kafartab with mangonels, compelling its defenders to surrender, before they besieged Shayzar but provides no more helpful details.

339 *Hic demum machinis congrua provisione dispositis, turres ac moenia, et infra muros civium domicilia gravium immissione molarium, incessanter concutiunt, et crebris ictibus et vicaria immissorum cautium repetitione, non sine multa inhabitantium strage funditus dejiciunt, in quibus erat defensionis spes maxima, aedificiorum munimina.* William of Tyre, *Chronicon* 15.1, ed. Huygens, 2:674, trans. Babcock and Krey, 2:94-95.

340 Niketas Choniates, *Historia*, trans. Magoulias, p. 18.

341 William of Tyre, *Chronicon* 15.1, ed. Huygens, 2:674, trans. Babcock and Krey, 2:95.

working in relays, as he states the fighting men were, there can be little doubt that these were traction- rather than counterweight-powered machines, the former being far more physically taxing and thus crews would more likely benefit from encouragement. So once more William of Tyre's assessment of the degree of damage appears to conflict with the manner in which it was inflicted.

Paul Chevedden has looked to other sources to argue that counterweight trebuchets were used against Shayzar. His theory is based largely on Ibn al-Adim's labelling of the Byzantine engines as *majaniq 'izam* (great mangonels) as well as Usama ibn Munqidh's designation of these engines as *majaniq ha'ilah* (huge/frightful mangonels).[342] However, Ibn al-Adim's account was written in the mid-thirteenth century and is less detailed than those of Usama and William of Tyre. Although Usama ibn Munqidh was a native of Shayzar and was certainly the closest source to these events, he was absent during the siege in 1138 and appears to have relied on the testimony of others.

Usama claims that the Byzantine artillery threw stones weighing 20 to 25 *ratls* to a distance greater than that of a bowshot.[343] If this loosely correlates to a weight of 50 kg (using the 2.14 kg *ratl* of Shayzar), and a range of close to 200 m, allowing for no exaggeration, this would be beyond the range of a traction trebuchet. However, it is unlikely that twelfth-century artillery was able to outrange a contemporary archer.[344] Similarly, the mass involved is also open to question. Although Usama was born in Shayzar, he held notable positions in both Damascus and Cairo during the mid-twelfth century. This opens up the possibility that he was using the 1.85 kg Syrian *ratl*, which would appear to cater to his intended audience, or even the 0.41 kg Egyptian *ratl*, closer to Hugh Kennedy's suggestion that the *ratl* was about half a kilogram.[345] If a 10 kg projectile was employed (using the Egyptian *ratl*) this could easily have been cast to a more reasonable range of 100 m by a traction trebuchet. While a significant counterweight trebuchet would have been able to throw the heavier mass the greater distance, there is only limited evidence to suggest the presence of one apart from the descriptions of structural damage. Although Usama claims that one shot destroyed an entire house and William of Tyre similarly states that large stones soared over the walls and caused destruction among the buildings within the enceinte, there is little descriptive,

[342] Chevedden, "Invention," pp. 92-93.
[343] Usama ibn Munqidh, *Kitab al-I'tibar*, trans. Cobb, p. 125.
[344] This has been discussed above in relation to the siege of Jaffa in 1123.
[345] Kennedy, "Shayzar," p. 12.

extrapolative or archaeological evidence to corroborate these colourful descriptions of destruction.

While Usama was not an eyewitness, in retelling stories told to him by one of his father's mamluks, he provides a grizzly personal perspective. As the defenders regrouped at one point during the siege, the man next to the storyteller turned to relieve himself and while doing so was struck on the head by a projectile cast by one of the Greek stone-throwers. The force of the projectile was sufficient to stick the man's head to the wall upon which he was leaning at the time. On a different occasion, a man was struck in the leg by such a shot and while others rushed to find a 'bonesetter' to tend to the broken leg another stone struck the wounded man on the head, crushing his skull.[346] These casualties do not convey a dramatic sense of power. Although sufficient to crush skulls and break other bones, there is nothing to suggest that the projectiles responsible for such injuries were any closer to 50 kg than to 10 kg or that they were thrown with a velocity closer to 50 m/s than 30 m/s. By comparison, Ammianus describes almost identical injuries inflicted by classical torsion-powered scorpions around eight centuries earlier.[347] Furthermore, the gruesome, yet limited, impact of these personal injuries appears to overshadow any notion of colossal destruction and detailed anecdotal evidence of particularly large stones causing structural damage are absent. So again there is no direct evidence to rule out the use of small counterweight trebuchets at this siege, but neither is there particularly strong evidence to support their presence.

Contrary to William of Tyre's notion that this was a "vigorous but ineffective siege of the city",[348] the assailants did eventually storm the town defences of Shayzar. Both Usama and Niketas Choniates claim that the Byzantine artillery was responsible for opening a breach in the town wall but only the former claims that this was stormed. This may reflect a similar situation to that which played out at al-Sawr in 1134, only in this instance John Comnenus was inclined to take a payoff from the Banu Munqidh rather than continue to besiege the citadel with the half-hearted aid of his Frankish allies.[349] After a siege of twenty-three days, according to Ibn al-Qalanisi, the Graeco-Frankish

[346] Usama ibn Munqidh, *Kitab al-I'tibar*, trans. Cobb, p. 126.
[347] Ammianus, *Rerum gestarum* 19.2.7, ed. Eyssenhardt, p. 144, trans. Yonge, p. 188.
[348] William of Tyre, *Chronicon* 15.1, ed. Huygens, 2:675, trans. Babcock and Krey, 2:96.
[349] William of Tyre, *Chronicon* 15.2, ed. Huygens, 2:675-76, trans. Babcock and Krey, 2:96-97. William of Tyre is generally hostile to both Frankish characters; but in their defence, Raymond was essentially being compelled to fight for a new fief that would exclude Antioch if Shayzar were to fall.

army withdrew back to Antioch.[350] Kamal al-Din claims that the Byzantines burnt their siege engines before departing but left some large mangonels, which Zanki moved into the citadel when he arrival not long after.[351]

Banyas: 1140

In 1140, forces of Jerusalem moved to support Damascus against the aggression of Zanki. In return for their assistance, Damascene forces accompanied the Franks in a move against Banyas, which had renounced its allegiance to Damascus in favour of Zanki. Mu'in al-Din Unar, regent of Damascus, arrayed his forces to the east of the city and the Franks took up positions to the west.

The artillery used by the forces besieging Banyas is described in similar terms to that used previously at Montferrand (1137) and Shayzar (1138). "From the hurling engines called petraries they threw huge stones of great weight, which shook the walls and demolished buildings within the city itself" wrote William of Tyre.[352] He adds that due to the showers of arrows and other projectiles, which fell against the fortified town, there was no safety to be found within and even those manning the ramparts scarcely dared to look out from behind the crenellated parapet. Notwithstanding what was evidently an impressive artillery barrage, confirmed by Ibn al-Qalanisi,[353] both chroniclers testify that it achieved little in advancing the siege.

Despite evocative descriptions of damage, the psychological impact would appear to have been at least as significant as the material damage. William may even have exaggerated his descriptions of physical damage in order to portray the psychological effects of such a barrage. Achieving few tangible results, the Franks turned to a staple in their siege arsenal: the siege tower.

Although the topography around Banyas was suitable for the use of a siege tower, there was apparently a shortage of suitable timber. This was one of the most lush and fertile areas of southern Syria but, revealingly, wood had to be brought from Damascus.[354]

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[350] Ibn al-Qalanisi, *Dhail*, trans. Gibb, p. 252.

[351] Kamal al-Din, *Bughyat*, RHC Or 3, p. 678. For a brief discussion of the siege and the sources, see Kennedy, "Shayzar," pp. 11-16.

[352] *...et machinis iaculatoriis, quas petrarias vocat, immissis magnae quantitatis molaribus, moenia concutiunt...* William of Tyre, *Chronicon* 15.9, ed. Huygens, 2:686, trans. Babcock and Krey, 2:108. This is William of Tyre's first use of the term *petraria* since his account of the First Crusade.

[353] Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 259-61.

[354] William of Tyre, *Chronicon* 15.9, ed. Huygens, 2:686-87, trans. Babcock and Krey, 2:108-9. Although William states that these beams were kept for just such a purpose, when considering the rarity with which Muslim forces employed timber-framed siege towers during the twelfth century, this seems unlikely. These,

These timbers seem only to have been intended for the frame of the siege tower, which required long straight posts for the four vertical supports of the structure. Unfortunately, the medieval walls of Banyas do not stand to their original height and thus cannot provide an indication of how tall the tower would have been or how tall its corner posts were. The scale of these posts is important because none of them appears to have been used to construct artillery. This indicates that it was not a material restriction that dictated the size of mid-twelfth-century artillery but rather a perception of its value or technological limitation. Unlike counterweight trebuchets, which could be built as large as the building materials and construction methods permitted, traction trebuchets had mechanically determined maximum dimensions.[355] It is also noteworthy that when William of Tyre subsequently speaks of the showers of stones and arrows cast down on the ramparts of Banyas from the siege tower, he uses very similar language to that which he employs when describing the effects of artillery. These hand-thrown/dropped stones would have been closer in size to those thrown by a traction trebuchet than by a counterweight engine. This again checks any tendencies to read the sources' descriptions of damage literally. Although the stones that were thrown from the siege tower would have been cast at a far lower velocity than those thrown by artillery, the change in trajectory facilitated by the siege tower denied the defenders the protection of their battlements, compelling the garrison to surrender.[356]

Edessa: 1144

Zanki more than compensated for the loss of Banyas with his acquisition of Frankish Edessa in 1144.[357] Seizing an opportune moment, he implemented what can be seen as a relatively standard Muslim siege tactic used in northern Syria: when a frontal assault was

among other 'war materials', were probably part of a general a general stockpile of materials, used to patch up defences and raise counter-towers during a siege.

[355] See Chapter 2.

[356] William of Tyre, *Chronicon* 15.10-11, ed. Huygens, 2:687-91, trans. Babcock and Krey, 2:109-12. Ibn al-Qalanisi does not mention the construction of a siege tower at any point in his account of the approximately twenty-three day siege. He instead attributes the town's eventual surrender to the effects of the blockade.

[357] Edessa had been besieged a number a number of figures in the century leading up to this: Alp Arslan (using a siege tower and mining) in 1070/71; Turkish forces (using artillery) in 1095/96, and then by Ridwan of Aleppo and Taghisiyan of Antioch after they broke the Turkish siege; Jokermish of Mosul in 1105/6; Kilij Arslan in 1106; Mawdud of Mosul in 1110 and 1112; al-Bursuqi's in 1115; and briefly by Turkish forces in 1138, Matthew of Edessa, *Patmowt'iwn*, trans. Dostourian, pp. 131-32, 162-63, 197, 199, 209-11, 215-16; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:106, 166; Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 1:265; *Anonymous Syriac Chronicle*, trans. Tritton, pp. 82-86.

impractical, he turned to mining, supported by light artillery. Although such a generalisation risks oversimplifying the broad variety of available siege tactics and particular preferences of various personalities, mining was frequently employed by Muslim commanders when frontal assaults failed and the use of mechanised stone-throwers is increasingly noted in support of it through the twelfth century, often placed alongside archers and slingers.

Gregory the Priest, followed by Bar Hebraeus, states that Zanki erected seven stone-throwers against the defenders manning the parapet of the city, but elaborates no more as he clearly implies that sapping was the focus of Zanki's siege plan.[358] According to the *Anonymous Syriac Chronicle*, each of the leading figures in Zanki's force erected a trebuchet. These engines, as well as the sappers, were responsible for inflicting damage on the city's walls; however, it was the latter who opened the breach that led to the city's fall.[359] The descriptions left by Ibn al-Qalanisi and William of Tyre, as well as the more extensive versed account of Nerses Shnorhali, reveal little additional information about the engines themselves or how they were used. All three confirm that mining contributed most to the city's fall.[360] The breach that led to the storming of Edessa appears to have been made near the north gate. Seven towers in this stretch of the defences required repairs after the siege, though whether the damage that they incurred was as a result of the mining or the artillery supporting it is unclear.[361]

The Second Crusade and the Ebb of Frankish Dominance

Zanki's successful siege of Edessa precipitated the Second Crusade. Despite the involvement of the leading barons of Outremer and many of the most prestigious lords of France and Germany, there are no indications that artillery, or any other type of siege

[358] Gregory the Priest, in Matthew of Edessa, *Patmowt'iwn*, trans. Dostourian, pp. 243-44; Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 1:268.
[359] *Anonymous Syriac Chronicle*, trans. Tritton, pp. 282-83.
[360] Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 266-68; William of Tyre, *Chronicon* 16.4-5, ed. Huygens, 2:717-21, trans. Babcock and Krey, 2:141-43; Nerses, *Voghb Yedesyo* ll. 835-1,146, RHC Ar 1, pp. 246-62. See also Ibn al-Athir, *al-Kamil*, trans. Richards, 1:372-73.
[361] *Anonymous Syriac Chronicle*, trans. Tritton, p. 289-90.

engine, was used during the climactic push against Damascus in 1148.[362] However, the preceding siege of Lisbon by certain contingents on their way to the Holy Land is one of the most informative sieges to any study of twelfth-century artillery.[363]

Lisbon: 1147

Fifty years after the crusader siege of Nicaea, and a continent away, a fleet of Anglo-Norman, German and Flemish contingents sailed into Lisbon in June 1147 on its way to the Levant. Despite the geographic separation, the ensuing episode clearly demonstrates the similarities between the siege tactics concurrently employed in Europe and the Near East. Importantly, the most detailed surviving eyewitness account of the ensuing siege, the anonymous *De Expugnatione Lyxbonensi*, provides revealing descriptions of the crusaders' artillery.

Disembarking against Moorish Lisbon, the crusaders surrounded the city: the Anglo-Normans to the west and the Germans to the east with the Flemings on their left.[364] Fifteen days after the siege had begun, the Franks began to construct siege engines. The Anglo-Normans built a siege tower and the contingents from Cologne and Flanders built a penthouse, ram and siege tower, as well as five *fundae Baleares* to support them. These 'Balearic slings' were mechanised stone throwers, directed against the walls and towers of Lisbon. The ensuing attack met with complete failure on all fronts and the Anglo-Norman siege tower, which became stuck in the sand, was an easy target for three defending pieces of artillery, which played upon it for four days and nights until it was finally burnt in a sally.[365] The inability of the defending artillery to destroy this immobile tower suggests that it was traction-powered and, in this regard, similarities can be drawn to the Frankish siege of Tyre in 1124.

Around September 1147, the Anglo-Normans employed two *fundae Baleares* of their own to cover mining efforts against an exposed section of the western wall:

> one on the river bank which was operated by seamen, the other in front of the Porta do Ferro, which was operated by the knights and their table companions. All these

[362] See William of Tyre, *Chronicon* 17.1-2, 5-7, ed. Huygens, 2:760-61, 65-69, trans. Babcock and Krey, 2:184-86, 190-95; Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 283-87; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:21-22.

[363] For Eurocentric interpretations of the importance of this account, see Köhler, *Die Entwickelung des Kriegswesens*, 1:164; Gillmor, "Introduction of the Traction Trebuchet," p. 2.

[364] *De Expugnatione Lyxbonensi*, ed. and trans. David, pp. 124-27.

[365] *De Expugnatione Lyxbonensi*, ed. and trans. David, pp. 134-37. For a similar use of the term, see Ralph of Caen, *Gesta Tancredi* 125, RHC Oc 3, p. 692.

> men having been divided into groups of one hundred, on a given signal the first hundred retired and another took their places, so that within the space of ten hours five thousand stones were hurled.[366]

This passage has formed the basis of many interpretations of mid-twelfth century artillery; but, unfortunately, some scholars have accepted it at face value and failed to analyse it more thoroughly.

These two sentences reveal a number of interesting details. Firstly, that one engine was worked entirely by seamen supports the link between artillery and nautical traditions.[367] This link is logical given the levered basis of trebuchet mechanics and the critical use of cordage. This was not a limiting factor though, as knights seems to have had no difficulty in operating the other engine. Secondly, the machines were again employed in an antipersonnel capacity: protecting mining efforts from sorties launched by the garrison and defenders along the parapet. Scholars who have dwelt on the number of men involved in the operation of these machines seem to have lost sight of this, preferring instead to see them as something larger and more threatening to the city's fortifications.[368] This leads to the third and most misinterpreted aspect of this episode: that the teams operating the machines were each composed of one hundred men, does not mean that one hundred men provided traction power at the same time. These engines were probably traction trebuchets but there were other tasks associated with these machines, such as collecting ammunition and guarding them. But what definitively rules out the possibility that all one hundred men made up a single pulling team is the essential mechanics. The distance that each man is able to pull limits the length of the short arm of the beam, which in turn limits the remaining mechanical variables and the space available for the men to pull from. Thus although adding a second puller might double the potential power of a single man, adding ninety-nine men will not produce one hundred times as much power.[369] Accordingly, there is no reason to believe that any more than approximately a dozen individuals provided the traction power for each of these engines at any one time.

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[366] *Insuper due funde Balearice a nostris eriguntur, una supra ripam fluminis a nautis trahebatur, altera contra portam ferream a militibus et eorum convictualibus. Hii omnes per centenos divisi, audito signo exeuntibus primis centenis, alii centeni subintrassent, ut inter decem horarum spatia V milia lapidum iactarentur. De Expugnatione Lyxbonensi*, ed. and trans. David, pp. 142-43.

[367] For a broader introduction to this relationship, see Rogers, *Latin Siege Warfare*, pp. 201-7. Cf. William of Tyre, *Chronicon* 8.9, ed. Huygens, 1:399, trans. Babcock and Krey, 1:357.

[368] For example, Chevedden, "King James I," pp. 324-25.

[369] See Chapter 2.

The fourth point of interest is the number of stones that were thrown: 5,000 shots over the course of 10 hours, or one shot every 7.2 seconds. If this rate of fire is anywhere near accurate the number of men gathering ammunition, let alone trying to shape any of it, would need to be many times that of the men working the two engines. It is unlikely, however, that the anonymous author counted the number of stones that were thrown. His estimation is thus either a reflection of the engine's rate of fire or an expression of the total number of stones thrown, two sides of the same coin. Accordingly, the author's figures should be interpreted as a reflection of his qualitative impressions rather than a quantitative reality.

The physical exertion required to achieve a rate of fire impressive enough to inspire such figures, would almost certainly have limited the relay periods to a matter of minutes rather than hours. If the author indeed meant that all one hundred men of each relay team took part in providing pulling power and that the total number of shots was divided between the two engines, it stands to reason that for each engine to support a rate of fire of around four shots per minute, a rate within the realm of possibility, each team was further subdivided. For instance, sub-crews of ten might have taken six-minute shifts, maintaining a maximum rate of fire and allowing the remaining ninety men to rest, gather ammunition and provide basic protection. The emphasis placed on crew size and rapid firing capability would appear to confirm that these were not counterweight trebuchets.[370]

The anonymous author makes it clear that the Frankish artillery was employed in a supporting role, and what it was supporting was not going well. With their mine more trouble than it was worth, the Anglo-Normans gave it up to build another siege tower, somewhat shorter than their earlier one. Steadfast in their approach, the men of Cologne and Flanders managed to undermine a section of the opposite wall of the city but the defenders held fast. The Anglo-Norman siege tower, supported by attacking artillery and capable of resisting the defenders' artillery, when pushed to within a few metres of the city, eventually compelled Lisbon's surrender.[371] At the contemporary Iberian sieges of Almeria (1147) and Tortosa (1148), Caffaro witnessed the similar use of *mangana* to

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[370] That they were is suggested in Bradbury, *The Medieval Siege*, p. 260. Nicolle has grasped this and suggests that either these machines were quite light or that this whole episode may be little more than the author displaying his knowledge of the efficiency of Balearic slingers in the classical Roman army, Nicolle, *Medieval Siege Weapons*, p. 15.

[371] *De Expugnatione Lyxbonensi*, ed. and trans. David, pp. 142-65. For secondary account of the siege, see Rogers, *Latin Siege Warfare*, pp. 183-88.

support siege towers, which were targeted by similar defensive engines.[372] Although he claims that stones weighing 200 pounds were thrown, Caffaro appears to contradict this when he suggests that rope netting was sufficient to protect one of the towers against them.

The siege of Lisbon reveals many similarities to the siege practices of the Franks in the Holy Land. The preference for siege towers shown by the Anglo-Normans seems to reflect that demonstrated by the Franks of Outremer during the first half of the twelfth century, while both made use of light artillery to support siege towers and sappers. It is the preference for mining shown by the contingents from Cologne that stands out. Although mining had been a tactic employed by Frankish forces at Nicaea in 1097 and numerous times since, it is generally viewed more as a Muslim tactic.[373] Although artillery was not employed by Frankish forces at Damascus, it was used soon after the Second Crusade collapsed, at the siege of Ascalon.

Ascalon: 1153

Numerous sieges took place between 1148 and the Frankish siege of Ascalon in 1153; however, the sources reveal little about the nature of any artillery that was used.[374] William of Tyre references very generally the use of 'throwing-engines' by both Baldwin III and his mother's supporters during the former's siege of the Tower of David.[375] During Nur al-Din's pushes against Damascus between 1150 and 1154, neither he nor the city's defenders appear to have made use of artillery,[376] even though it would seem such engines were being stored inside the city by this point in history.[377]

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[372] Caffaro, *Ystoria*, ed. Belgrano, pp. 80-88, trans. Hall and Phillips, pp. 128-35.

[373] This interpretation is widely held and is accurate to a degree. The topography of coastal Palestine influenced the apparent Frankish preference for siege towers during the first two decades of the twelfth century; however, mining appears more frequently as a siege tactic than does the construction of siege towers thereafter. The rougher terrain away from the coast reduced the opportunities to employ siege towers, encouraging mining.

[374] These include a number of sieges conducted by Nur al-Din and Kilij Arslan as they mopped up what remained of the county of Edessa, largely under Byzantine control at this point, Ibn al-Azraq, *Tarikh*, trans. Hillenbrand, pp. 132-34; William of Tyre, *Chronicon* 17.16-17, ed. Huygens, 2:781-85, trans. Babcock and Krey, 2:208-12; Gregory the Priest, in Matthew of Edessa *Patmowt'iwn*, trans. Dostourian, p. 260; Ibn al-Qalanisi, *Dhail*, trans. Gibb, p. 309-12. For Nur al-Din's second push into this region a decade later, see Gregory the Priest, in Matthew of Edessa, *Patmowt'iwn*, trans. Dostourian, pp. 269-70, 276-77; Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 356-57.

[375] William of Tyre, *Chronicon* 17.14, ed. Huygens, 2:778-80, trans. Babcock and Krey, 2:206-7.

[376] Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 297-300, 302-8, 318-20; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:71.

[377] Fulton, "Development of Prefabricated Artillery," pp. 56-57. See also Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 310, 312-13.

Ascalon was an ancient strongpoint on the southern coast of Palestine. Its medieval fortifications were founded on Bronze Age defences and contained elements of late Roman, Umayyad and Fatimid construction.[378] Like most twelfth-century fortifications along the coast of Palestine, the defences of Ascalon were built using the local *kurkar*, soft sandstone composed of fossilised sand washed into the Mediterranean from the Nile. The mortar was a compound of lime, sand, potsherds and ash, which formed a bonding agent slightly harder than the stone itself and more resistant to the natural elements. These defences were manned by a sizable professional garrison during the first half of the twelfth century, regularly supplied and rotated out by the Egyptian fleet.[379]

Baldwin III led his army against Ascalon in January 1153 while Gerald of Sidon attempted to impose a naval blockade.[380] Additional ships were procured and stripped for their timber with the arrival of a wave of pilgrims around Easter. The masts of these vessels were used to form the frame of a siege tower and the remaining wood was used to make penthouses and artillery. William of Tyre provides another of his conflicting descriptions when he states that the artillery was arrayed in ideal positions to batter down the walls but then clearly depicts it in a supporting role, providing covering fire for the siege tower and those preparing the ground ahead of it.[381] The *Anonymous Syriac Chronicle* claims that the Franks employed a stone-throwing machine on top of the siege tower and emphasises the threat that this posed to those walking around inside the city.[382]

The Frankish attack wore on into the summer and the barrage seems to have been most intense around the east-facing Jerusalem Gate. Despite William of Tyre's assertion that "Volleys of mighty rocks hurled from the casting machines threatened to weaken the walls and towers and to overthrow from their very foundations the houses within the city",[383] it seems that the integrity of the walls was never seriously imperilled by the Frankish artillery despite this prolonged period of exposure. Instead, the assailing artillery

[378] Pringle, "Crusader Castles and Fortifications," pp. 357-72; Benvenisti, *The Crusaders*, pp. 123-28; Pringle, "Richard I," p. 135.
[379] Pringle, "Town Defences," pp. 84-85; William of Tyre, *Chronicon* 17.22, ed. Huygens, 2:790-92, trans. Babcock and Krey, 2:219-20. William of Tyre repeated mentions the city's reliance on a regular schedule of supply shipments from Egypt in books 13 and 17.
[380] William of Tyre, *Chronicon* 17.21, ed. Huygens, 2:789-90, trans. Babcock and Krey, 2:217-18.
[381] William of Tyre, *Chronicon* 17.23-24, ed. Huygens, 2:792-94, trans. Babcock and Krey, 2:220-23.
[382] *Anonymous Syriac Chronicle*, trans. Tritton, p. 301.
[383] *...tormentis nichilominus iaculatoriis turres ac menia debilitare et infra urbem non sine strage multa funditus dissolvere, immissis magnis molaribus, domicilia*. William of Tyre, *Chronicon* 17.27, ed. Huygens, 2:797, trans. 2:225-26.

should again be more accurately categorised as an antipersonnel weapon, fulfilling a similar function to the archers in the siege tower. Revealingly, it is the garrison, rather than Ascalon's defences, that is portrayed as suffering most from the Frankish artillery (mislabelled *balistae*) in the *Auctarium Aquicinense*.[384]

Keeping with the established tradition, the Franks' siege tower remained the focal point of their offensive. The tower was also viewed by the defenders as the greatest threat to their security and it was against it, rather than the attacking artillery, that the garrison directed most of its efforts. The defenders eventually breached their own walls during an attempt to burn the siege tower, leading them to surrender soon after and allowing the Franks to occupy the city on 12 August.[385]

<u>Banyas: 1157</u>

While the main army of Jerusalem was besieging Ascalon, Nur al-Din had briefly attempted to take Frankish Banyas before moving on to assume power in Damascus.[386] He returned to Banyas in 1157.[387] Ahead of this, Nur al-Din travelled to Damascus where, according to Ibn al-Qalanisi, "He gave orders to dispatch what mangonels and weapons were required to the victorious 'askar", then rallied what remaining forces he could from the city and made for Banyas.[388] In surprising similarity, William of Tyre states, "He summoned his cavalry, had his engines of war moved to the place, and suddenly appeared before the city."[389] Thus, both Frankish and Muslim sources confirm that artillery was being stockpiled in Damascus by the start of the second half of the twelfth century. To warrant storage, these engines must have been viewed as sufficiently valuable to incur

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384 *Auctarium Aquicinense*, MGH SS 6, p. 396. See also *Auctarium Affligemense*, MGH SS 6, pp. 401-2.
385 William of Tyre, *Chronicon* 17.27, ed. Huygens, 2:797-99, trans. Babcock and Krey, 2:225-27.
386 William of Tyre, *Chronicon* 17.26, ed. Huygens, 2:796, trans. Babcock and Krey, 2:225; Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 314-16.
387 The town itself was composed of a roughly rectangular enclosure, smaller than 300 m square, and sported defences prior to the Frankish presence the Holy Land. What were interpreted as Frankish building works in the nineteenth century, roughly resembling those encountered by Nur al-Din in 1157, have since been judged to be more likely of Ayyubid or Mamluk construction. If the quadrangular projecting towers and curtain postdate the siege, the footprint was the same. The north and western sides were swept by the river while the south enjoyed the protection of a valley. The eastern side was the most vulnerable and it can be assumed that this side was always the most heavily fortified. See Conder and Kitchener, *Survey of Western Palestine*, 1:110-11; Pringle, *Secular Buildings*, no. 42, p. 30; Pringle, "Town Defences," p. 92.
388 Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 333-34. Abu Shama places his departure from Damascus on 12 May 1157, Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 86.
389 *Nec mora, sumpta ex tempore oportunitate Noradunus et ex predicto successu factus elatior apposuit eandem urbem, casu predicto consternatam, obsidere convocataque militia et machinis comportatis ex inproviso ante urbem obsidione*. William of Tyre, *Chronicon* 18.12, ed. Huygens, 2:827, trans. Babcock and Krey, 2:257.

the costs associated with their transportation and maintenance relative to those involved with building new engines *in situ*.[390]

Having surrounded the town and set up his artillery, Nur al-Din began the siege on 18 May 1157. The sources emphasise that a barrage of stones and arrows was unleashed on the defenders but again the artillery seems to have inflicted greater psychological damage than physical. The Muslim army gained entrance to the town either after a mine was successfully lit or a careless sally by the garrison allowed their assailants to overcome them before they were able to withdraw back into the town and secure the gate behind them.[391] The garrison withdrew to the citadel but were soon relieved by a force led by Baldwin III in mid-June. Nur al-Din was able to defeat this relief force soon after its arrival, compelling the king to seek refuge in Safed and allowing Nur al-Din to return to Banyas.[392] According to William of Tyre, Nur al-Din once more encircled the town "and set up his numerous engines in strategic positions. The mighty blows of the stone missiles shook the towers and weakened the walls."[393] However, it is questionable whether Nur al-Din would have been able to bring any significant artillery to bear against Banyas in this second effort. It seems unlikely that these would have been the same machines that had been employed in May as both the surprise appearance of Baldwin's force and the mobility that Nur al-Din's forces demonstrated in defeating the army of Jerusalem suggest that he would not have been moving with a siege train. Had he not burnt his engines prior to leaving Banyas, they would almost certainly have been destroyed by the garrison on his second approach if they had not already been brought into the town or destroyed during the intermittent period when repairs were carried out. Despite his initial defeat, Baldwin was still able to break this second siege with the arrival of aid from Antioch and Tripoli; the weakened garrison having opted to defend only the citadel on this occasion.[394]

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[390] See Fulton, "Development of Prefabricated Artillery," 51-72. This appears to differ from the timber that was used to construct the siege towers when Banyas was besieged in 1140, see above.

[391] William of Tyre, *Chronicon* 18.12, ed. Huygens, 2:827-28, trans. Babcock and Krey, 2:257-58; Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 333-35; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 87-88. William of Tyre offers the latter scenario but claims that mines were used to slight the town's defences after it fell, leaving the possibility that work on these mines might have begun before the town was taken.

[392] William of Tyre, *Chronicon* 18.13-14, ed. Huygens, 2:828-32, trans. Babcock and Krey, 2:258-62.

[393] *...machinis frequentibus et ordine congruo dispositis, turres concutit, moenia debilitat et crebra sagittariorum opera, et telorum, instar grandinis, immissione, eos qui intus se receperant, vices prohibet exercere resistentis.* William of Tyre, *Chronicon* 18.15, ed. Huygens, 2:832, trans. Babcock and Krey, 2:262-63.

[394] William of Tyre, *Chronicon* 18.15, ed. Huygens, 2:832-33, trans. Babcock and Krey, 2:262-64.

Shayzar and Harim: 1157

Nur al-Din's move on Banyas took place during a devastating series of earthquakes that were felt throughout Syria in 1156-57. In October 1157, the Franks took advantage of this destruction to move first against Shayzar and then Harim, emboldened not only by the extensive damage but also by the arrival of Thierry of Flanders on his third crusade and a bout of illness that afflicted Nur al-Din.

Artillery was used to support frontal assaults at the siege of Shayzar, which proved unsuccessful, and it helped to sustain a blockade and cover mining efforts that led to the capture of Harim.[395] These engines may have been most effective as psychological weapons, as at neither siege are they portrayed as being particularly strong. Nur al-Din appears to have employed artillery with a similar psychological intent during his successful siege of Harim in 1164,[396] while his use of stone-throwers at Banyas later the same year is another clear example of their successful use to support mining efforts.[397]

Egypt: A New Frontier

Alexandria: 1167

During the 1160s, Amalric of Jerusalem's foreign policy was largely concerned with Egypt. During a campaign in Egypt in 1167, in what had become a fight with Nur al-Din's forces over the weakened spoils of the Fatimid state, Amalric besieged Alexandria. The city was defended initially by Shirkuh, Nur al-Din's commander in Egypt, until he left for Upper Egypt leaving command to his nephew, Saladin.

The Franks initially imposed a blockade from a distance and pillaged the surrounding area. But with Shirkuh's escape through the blockade, a more active approach

[395] For Shayzar, Ibn al-Athir, *al-Kamil*, trans. Richards, 2:89; William of Tyre, *Chronicon* 18.18, ed. Huygens, 2:836, trans. Babcock and Krey, 2:267. For evidence of Nur al-Din's reconstruction efforts at Shayzar in the aftermath of these earthquakes, see Tonghini and Montevecchi, "Shayzar: Recent Archaeological Investigations," pp. 140-50. For Harim, William of Tyre, *Chronicon* 18.19, ed. Huygens, 2:838-40, trans. Babcock and Krey, 2:269-71; Ibn al-Qalanisi, *Dhail*, trans. Gibb, p. 344; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 96.

[396] William of Tyre, *Chronicon* 19.9, ed. Huygens, 2:874-75, trans. Babcock and Krey, 2:306-8; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:146-48; *Anonymous Syriac Chronicle*, trans. Tritton, pp. 303-4.

[397] William of Tyre, *Chronicon* 19.10, ed. Huygens, 2:877, trans. Babcock and Krey, 2:309-10; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:148-49; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:47.

was adopted.[398] It is only during this second stage of the siege that any kind of machinery is noted. William of Tyre describes the situation in fairly familiar terms:

> The besieging host assembled before the city now collected an immense number of masts, summoned craftsmen and carpenters, and caused them to erect a tower of great height from whose top the entire city could be surveyed. Machines called petraries which hurled forth enormous stones of great weight were also placed in strategic positions around the walls. From these, almost incessantly, were hurled immense stones of great weight which shattered the walls and terrified the people almost beyond endurance.[399]

The statement is essentially a compilation of stock phrases, from the ability to survey the town from the tower to the throwing of large stones that terrorised those within and wrought damage on the town's defences. But with the possible exception of the Graeco-Frankish siege of Shayzar in 1138, none of these supposed breaches or weakened walls was subsequently stormed by assailing Frankish forces, confirming that the impact of these projectiles was somewhat less dramatic than William's language would suggest. His reference to the constant firing of stones is a tenuous indication that these may have been traction trebuchets. In this light, William's repeated claims that projectiles 'smashed walls', may more accurately be read as 'smashed against walls' and the 'great' size of the stones should perhaps be seen in relation to the scale of a stone that a slinger would typically throw.

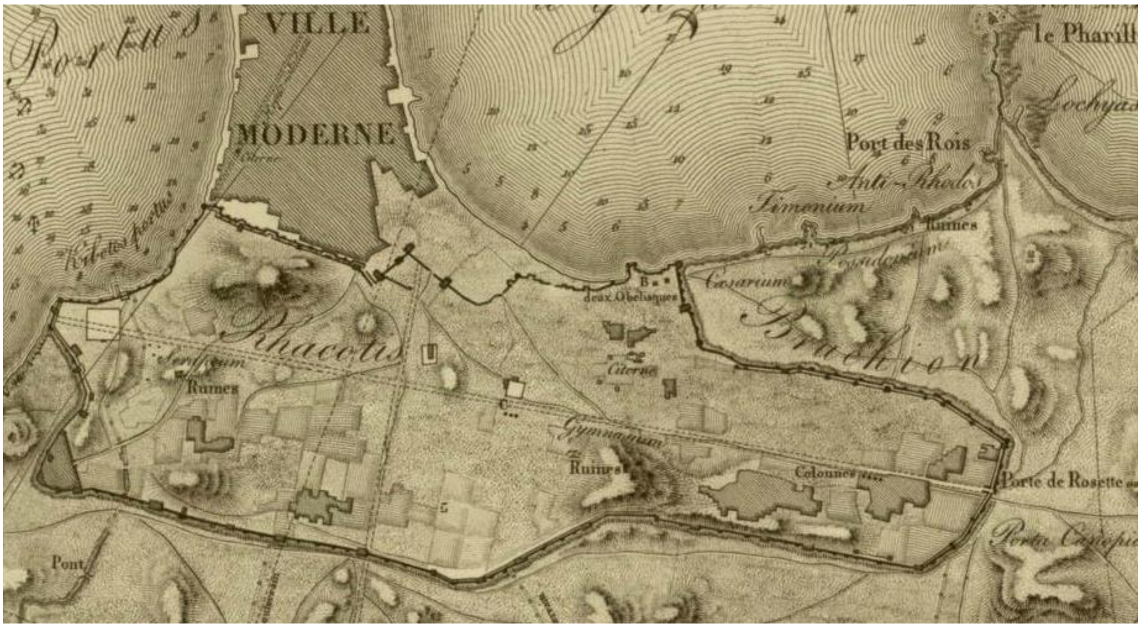
The materials that were used to build the Frankish artillery at Alexandria, wood from orchards and fruit trees,[400] were entirely inappropriate for constructing counterweight engines of sufficient size to threaten the fortifications. Even if the beams and main struts had been fashioned from spars lashed together, the short and far from straight nature of these trees would have limited the size and strength of any engine. This would have made traction trebuchets by far the most practical artillery option. As at Caesarea (1101), Banyas (1140) and Ascalon (1153), the timber that would have been

[398] William of Tyre, *Chronicon* 19.26, ed. Huygens, 2:901-2, trans. Babcock and Krey, 2:334-35; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 132-33. For the wider campaign see Ibn al-Athir, *al-Kamil*, trans. Richards, 2:163-64. See also Omran, "King Amalric," pp. 191-96.

[399] *Hic demum sumptis navium malis inmense quantitatis, vocati artifices, lignorum cesores, castellum erigunt mire altitudinis, unde totam despicere erat civitatem; machine quoque, quas vulgo petrarias vocant, unde missi molares graves et magni muros cedebant, congruis stationibus locate intolerabilem civibus, horis pene omnibus, inferebant terrorem*. William of Tyre, *Chronicon* 19.18, ed. Huygens, 2:903-4, trans. Babcock and Krey, 2:337.

[400] William of Tyre, *Chronicon* 19.28, ed. Huygens, 2:903-4, trans. Babcock and Krey, 2:337.

Alexandria: town, plan (from *Description de l'Égypte*)



suitable for a larger counterweight trebuchet was instead earmarked for the construction of a siege tower.

The inability of the Franks to inflict more damage than would appear to have been the case is noteworthy when considering the security that they enjoyed during this siege. The local population of Alexandria was as hostile towards their Syrian 'defenders' as they were to the assailing Franks. This discouraged the garrison from launching sallies against their besiegers and left the Franks to conduct their siege in relative security.[401] Under such conditions, the meagre power of the Frankish artillery is further revealed.

<u>Damietta: 1169</u>

In 1169 the Franks, with Byzantine aid, launched their first campaign against the port of Damietta. Near the mouth of one of the two main branches of the Nile delta,[402] the city controlled access upstream by a tower, set in the middle of the river, that was connected to the town by a chain that extended across the main shipping lane. This would not be the last time a Frankish army would come up against this tower.

Upon their arrival in the region the Franks paused, allowing support and provisions to pour into Damietta.[403] When siege efforts began, "It soon became apparent

401 William of Tyre, *Chronicon* 19.29-32, ed. Huygens, 2:905-9, trans. Babcock and Krey, 2:339-43; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:164-65.
402 Then, as now, the other main branch entered the Mediterranean at Rosetta.
403 Ibn al-Athir and Baha' al-Din credit this support to Nur al-Din and Saladin respectively, Ibn al-Athir, *al-Kamil*, trans. Richards, 2:183-84; Baha' al-Din, *al-Nawadir*, trans. Richards, p. 46.

that without the assistance of machines (*machinae*) and engines of war (*tormenta bellica*) Damietta could not be taken, although on the arrival of the Christians it had seemed scarcely able to sustain the first attack."[404] Having opted not to make an initial general assault, the attacking forces had committed themselves to a set-piece siege.

According to William of Tyre, the siege tactics relied heavily on siege engines.[405] The showpiece of the Frankish machines was a supposedly seven-storey siege tower. In addition to this, penthouses and artillery were also constructed. The latter is described in familiar terms, inflicting damage on the parapets and buildings beyond when they overshot the walls.[406] William claims that the Byzantines used their fleet to transport engines to Egypt; this is apparently confirmed by Baha' al-Din, who indicates that the Christians brought their siege equipment with them.[407] Niketas Choniates, who downplays the significance of the Frankish siege tower, emphasises instead the frontal assaults that the Greeks made using ladders. He does not say whether or not the Greeks brought any engines with them but clearly states that artillery was employed with some effect by at least some Byzantine elements.[408] All three sources allude to the garrison's use of artillery without explicitly describing it, ambiguously referring to these engines with variants of 'machines of war'.[409]

The siege was eventually abandoned as supplies wore thin and the Frankish siege tower failed in its assault against the most approachable, but equally heavily defended, front of Damietta. Forced to withdraw, the next Christian invasion of Egypt was orchestrated neither in Acre nor in Constantinople.

Alexandria: 1174

At the end of July 1174, Norman forces from Sicily attacked Alexandria. Possibly intending to coordinate with a Shi'ite coup against Saladin, which had miscarried earlier in the year, the force landed near the Ptolemaic lighthouse. A letter written by Saladin, which forms the basis of most Muslim accounts of this siege, claims that six ships of the Sicilian fleet, distinguished from the galleys and troop-carriers, bore siege engines and

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404 William of Tyre, *Chronicon* 20.15, ed. Huygens, 2:929, trans. Babcock and Krey, 2:364.
405 William of Tyre was a notable figure in the kingdom of Jerusalem by this time; however, he was out of the realm on diplomatic missions during much of 1169, William of Tyre, *Chronicon* 20.17.
406 William of Tyre, *Chronicon* 20.15, ed. Huygens, 2:929-30, trans. Babcock and Krey, 2:364.
407 William of Tyre, *Chronicon* 20.13, ed. Huygens, 2:927, trans. Babcock and Krey, 2:361; Baha' al-Din, *al-Nawadir*, trans. Richards, p. 46.
408 Niketas Choniates, *Historia*, trans. Magoulias, pp. 92-95.
409 Cf. Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 151-53; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:183-84.

men who built artillery.[410] Having made their landing, the Sicilians pushed the Muslims back to the walls of Alexandria while their fleet occupied the harbour. By the following day, they had finished setting up their engines and advanced them towards the city walls. No less than three siege towers, equipped with rams at their lowest levels and three stone-throwers are said to have been employed by the attackers. On days four and five of the siege, 31 July and 1 August, the garrison launched successful sallies, at first burning the Sicilian siege towers and then defeating the besieging force itself. The Franks who survived withdrew, abandoning their remaining machinery.[411]

The way in which the Muslim sources treat the Frankish artillery is tantalising and enigmatic. That only three stone-throwers should be mentioned next to an equal complement of ram-equipped siege towers and be designated as 'big' by some of the Muslim sources may suggest that there was something exceptional about these engines. This idea becomes more alluring when they are noted to have thrown black, presumably volcanic, stones brought from Sicily. It is unlikely that stone projectiles would have been imported for traction trebuchets, given their limited power and high rate of fire. At a modest rate of four shots per minute, a sustained period of fire from a single engine would consume an astounding 240 shots per hour. Thus even if the Sicilians recognised that finding suitable stones for projectiles might be more difficult in the Delta than other regions, it is unlikely that a sufficient number of stones could have been transported to Alexandria to sustain even one traction trebuchet. Instead, the prominent notice given to these three machines, on equal footing with the siege towers, and the transportation of special ammunition, suggests the presence of counterweight trebuchets. The slow rate of fire and high impact velocity of such engines would certainly warrant special projectiles and may even have overshadowed the presence of lighter traction engines that escaped notice.[412]

The projectiles thrown by these three trebuchets are described as being large and apparently hit the walls of Alexandria with impressive violence, a portrayal with

410 Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 165-66. See also al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 49.

411 Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 164-67; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:229-30; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 48-50. See also Baha' al-Din, *al-Nawadir*, trans. Richards, p. 50; William of Tyre, *Chronicon* 21.3, ed. Huygens, 2:963, trans. Babcock and Krey, 2:399-400.

412 The only explanation that I can think of for why Sicilian stones would be thrown by traction trebuchets is that these were ballast stones. To do this, however, would imply that the Sicilians were extremely confident in their ability to take the city, believing that they could substitute the weight of the stones with booty on their return home. This appears to be an unlikely possibility when considering that the Sicilian force was so small that it was defeated by the garrison before Saladin arrived to relieve them.

longstanding precedent. However, the black, presumably volcanic, rock would have been harder than the available local stone and that with which Alexandria's defences were built.[413] This gave the Sicilians the same advantage that Richard I of England would enjoy seventeen years later when he too brought stone projectiles from Sicily to the siege of Acre.[414]

Although there is reasonable circumstantial evidence to propose the possibility that counterweight trebuchets were used by the Sicilians in 1174, the logistics of the siege expose this to question. According to the time scheme repeated by the various Muslim sources and confirmed by William of Tyre,[415] the Sicilians landed, assembled and deployed their siege engines in less than thirty-six hours. This limited period of time would have necessarily restricted the potential size of the assailing machinery. Furthermore, having landed on 28 July and initiated the siege the following day, 30 July was the only full day that the Sicilians were able to bombard the city uninhibited: a number of engines were burnt during a sortie by the garrison on 31 July and the Sicilians were routed the following day ahead of Saladin's arrival on 2 August. This timetable would have prevented any medieval artillery from threatening contemporary fortifications, let alone allowing a multi-storey siege tower to do so.[416]

The Sicilians' use of what may have been relatively unique engines in 1174 is significant when considering their siege of Thessalonica in 1185. Eustathius of Thessalonica claims that the Sicilians employed an array of artillery that included large and small engines of a supposedly traditional type, used in addition to mining on one side of the city, as well as some of a supposedly new variety.[417] Although the latter proved cumbersome and ineffective on account of their size, it is likely that these, and possibly even some of the large traditional engines, were counterweight trebuchets.

Despite certain embellishments, the accounts of the siege of Alexandria provide plausible evidence that counterweight trebuchets were employed by a Latin force in the

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[413] Randal Rogers has proposed that these black stones were supposed to fragment upon impact; however, this seems unlikely given the geology involved, Rogers, *Latin Siege Warfare*, p. 121.

[414] See Chapter 5. Cf. the supposedly impregnable castle built near Damietta during the Fifth Crusade, Vitry, *Lettres*, no. 7, ed. Huygens, pp. 139-40. See also Pringle, "A Castle in the Sand," pp. 189-90.

[415] William of Tyre claims that the Sicilians' siege lasted five or six days, William of Tyre, *Chronicon* 21.3, ed. Huygens, 2:963, trans. Babcock and Krey, 2:399-400.

[416] It took the Franks assailing the cities of Palestine, fifty to seventy-five years earlier, the better part of a month to construct their siege towers. At Jerusalem, it took Godfrey of Bouillon all of three days to reassemble his siege tower from components just light enough to be moved in the field, rather than any so small that they could be stowed on board a ship.

[417] Eustathius of Thessalonica, *Capture of Thessalonica*, ed. and trans. Melville Jones, pp. 72-105.

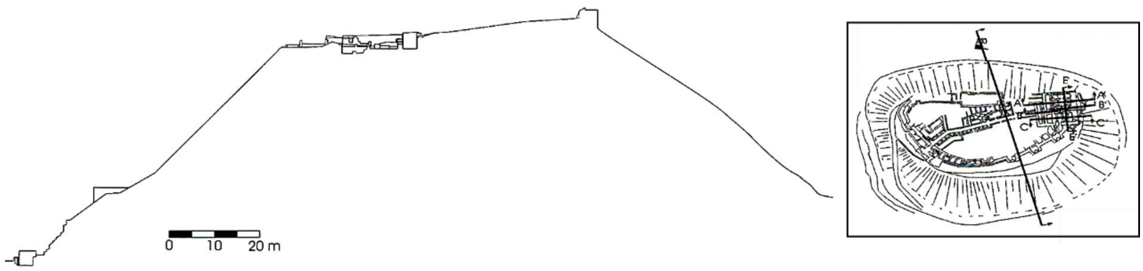
theatre of the crusades before the Third Crusade. This is not to say that this was the first time that such engines were used in or around the Latin East, only that this appears to be the first recorded instance that is supported by a reasonable degree of circumstantial evidence. Likewise, this does not imply that these were monstrous machines comparable to those constructed in the fourteenth century, only that they were strong enough that the value of their greater power, when coupled with imported ammunition, outweighed their reduced rate of fire. In any case, this is a rare example of prefabricated artillery being employed by Latin armies in the Levant during the twelfth century. A more typical example of Frankish artillery tactics in the closing decades of the twelfth century is found at the siege of Harim.

Harim: 1177

Philip of Flanders arrived in the Holy Land in August 1177 and marched north alongside Raymond III of Tripoli and Bohemond III of Antioch that autumn. After a brief move against Hama, the Frankish force invested Harim, then in revolt against al-Salih of Aleppo. Upon arrival, the Franks built huts to show their determination and artillery to support frontal ladder-assisted assaults, the topography rendering a siege tower

Harim: castle, plan (from Gelichi)

Harim: castle, section (from Gelichi)



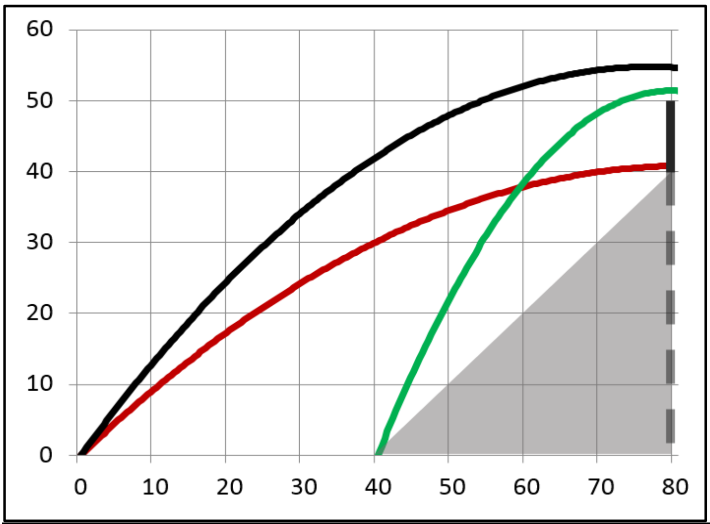
impractical.[418] The siege was not pressed particularly hard and after a lengthy stay, as long four months, Bohemond was satisfied with a payoff while Philip of Flanders was content just to leave. With their departure, al-Salih moved in to finish off the beleaguered garrison, which quickly came to terms.[419]

Despite the stronghold's inaccessibility, William of Tyre notes that the Frankish artillery that was arranged around the castle could still harass it from all sides, as appears to have been the case during Nur al-Din's siege of the castle in 1164.[420] The castle sits on top of a tell, roughly 40 m high, and it would appear that access was unobstructed to the base of its sides, which rise at an angle of about 45°. If William's account is accurate and some shots cleared the castle's battlements, these projectiles must have been released at a minimum velocity of 34 m/s (assuming the curtain wall was approximately 10 m tall). If the Frankish engines were capable of releasing projectiles at 40 m/s, they could achieve the same result at a distance of 40 m from the base of the tell (80 m from the vertical plane of the wall) using a release angle of 55°. If it was the walls rather than the battlements that were assailed, the release angle could be lowered to 45°, increasing the horizontal velocity of any projectiles by over 5 m/s.

[418] William of Tyre, *Chronicon* 21.18 (19), ed. Huygens, 2:986-87, trans. Babcock and Krey, 2:425-26; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:255-56. For the defences of Harim, see Gelichi, "The Citadel of Harim," pp. 184-200; Gelichi, "Die Burg Harim," pp. 211-20.

[419] William of Tyre, *Chronicon* 21.18 (19), 24 (25), ed. Huygens, 2:986-87, 994-96, trans. Babcock and Krey, 2:425-26, 434-35; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:254-56; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 191-93.

[420] William of Tyre, *Chronicon* 21.24 (25), ed. Huygens, 2:995, trans. Babcock and Krey, 2:434-35. For Nur al-Din's siege of Harim in 1164, see William of Tyre, *Chronicon* 19.9, ed. Huygens, 2:874-75, trans. Babcock and Krey, 2:306-8; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:146-48; *Anonymous Syriac Chronicle*, trans. Tritton, pp. 303-4.



Release Angle (α)	45°	55°	69°
Velocity (V)	40 m/s	40 m/s	34 m/s
Horizontal Velocity (Vh)	28.28 m/s	22.94 m/s	12.18 m/s
Max. Horizontal Range (Rh)	163.27 m	153.42 m	78.93 m
Max. Vertical Range (Rv)	40.82 m	54.78 m	51.40 m

Although an apparently small difference, when one considers that a projectile's horizontal velocity accounts for its total velocity at the apex of its flight path, the projectile released at 45° would be travelling 23% faster than the projectile released at 55° at this point in flight. When considering that kinetic energy is half the product of mass and velocity squared [$\mathrm{Ek} = \frac{1}{2}(\mathrm{m} \cdot \mathrm{V}^2)$], the former would carry 52% more energy than the latter if they both had a mass of 10 kg.

Projectile Mass (Mp)	**Kinetic Energy at 28.28 m/s (45°) (Ek)**	**Kinetic Energy at 22.94 m/s (55°) (Ek)**
1 kg	399.9 J	263.1 J
5 kg	1,999.4 J	1,315.6 J
10 kg	3,998.8 J	2,631.2 J
50 kg	19,994.0	13,156.1 J

Although a projectile's real velocity would be at its lowest when it reached the apex of its flight path, if it struck the vertical exterior face of a wall at this point, the perpendicular angle of impact would allow for the most efficient transfer of energy. In theory, an oblique angle of impact would be ideal when targeting the corner of a polygonal structure, such as a tower or even a merlon. In practice, however, if the strength of the targeted structure was so great and the mass of the projectile so small as to make this approach appear attractive, the engine in question could almost certainly be employed more productively firing at a different target, given the amount of time it would take to inflict any significant damage.

As the mass of the projectiles thrown at Harim is unknown, the force with which they were tossed is unclear. However, considerations of range can be used to assess the possible presence of counterweight-powered engines. An engine capable of a releasing a projectile at 34 m/s has a theoretical horizontal range of 118 m (if fired at 45°) and a comfortable range of 102 m (+/-15°) – comparable with the range of some modern reconstructed traction trebuchets.[421] If a release velocity of 40 m/s were possible, projectiles could in theory be thrown up to 163 m (141 m +/-15°). This appears to have been on the very edge of possibility for a traction trebuchet. These engines had to throw quite small projectiles (generally less than 10 kg) in order to achieve release velocities exceeding 30 m/s, whereas counterweight trebuchets could release significantly heavier stones at this speed.

Although there appears to be little evidence to suggest that counterweight trebuchets were used at Harim in 1164 or 1177, suggesting it was the defenders on the parapet rather than the walls below them that were targeted, neither is there enough evidence to rule out their presence conclusively. It is through many of Saladin's sieges in the late-1180s that more conclusive evidence for the use of these heavier engines becomes apparent. But before investigating these sieges, it is pertinent to look at Saladin's earlier use of artillery.

The Rise of Saladin

Jacob's Ford: 1179

In 1175 and 1176, Saladin used artillery against a number of Muslim strongholds in Syria and, in 1179, 'Imad al-Din implies that Saladin intended to use it against the newly built Frankish castle at Jacob's Ford.[422] Although this siege has become the focus of some discussion, little attention has been given to this reference to artillery.[423] 'Imad al-Din

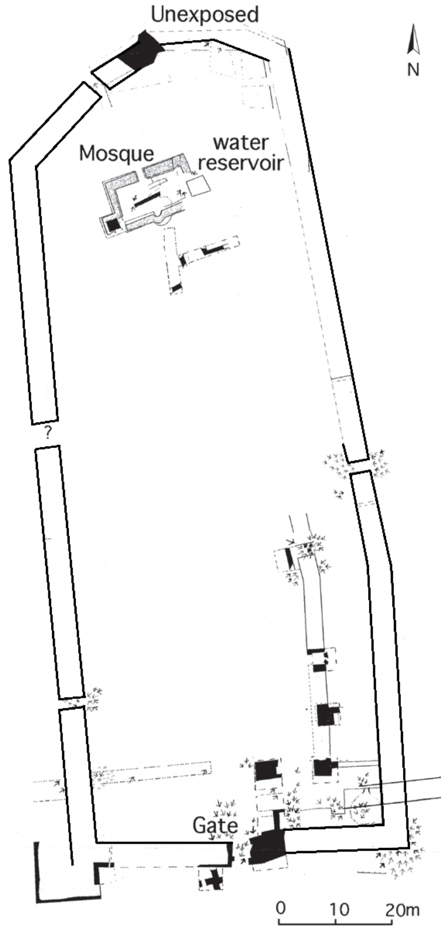
[421] See Appendix 4.

[422] For an overview of Saladin's use of artillery, see Appendix 2.

[423] For discussions of Jacob's Ford, see Ellenblum, et al., "Crusader Castle," pp. 258-74; Barber, "Frontier Warfare," pp. 9-22. For descriptions of the castle, see Boas, *Crusader Archaeology*, pp. 118-20; Pringle,

states that wood and vine poles were gathered from around Safed to build protective screens for the Muslim artillery,[424] apparently a routine procedure as Saladin had similar defences built for his artillery when he besieged Jerusalem in 1187.[425] However, artillery is not mentioned following the start of the siege and not a single identifiable projectile has been uncovered during recent excavations at the castle.[426] The apparent absence of artillery speaks to the speed of this siege: despite an initial mining setback, the castle fell to a frontal assault less than a week after the siege began.[427] While there have certainly been previous examples of artillery being erected in shorter periods of time than this, the rapid progress that Saladin's forces were making against the castle probably discouraged him from setting up his artillery after it arrived.

Jacob's Ford: distribution of arrowheads, plan (after Raphael and Ellenblum)



When Saladin initially crossed the Jordan, he left his baggage at Banyas and it stands to reason that any prefabricated artillery that he might have been moving with the army would have been left here as well. Accordingly, the early efforts to gather materials to establish a fortified artillery position probably began before the engines arrived. Prefabricated

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Secular Buildings, no. 174, p. 85; Benvenisti, *The Crusaders*, pp. 304-5; Conder and Kitchener, *Survey of Western Palestine*, 1:250-51; Guérin, *Description*: *Galilée*, 2:341. Unfortunately, no comprehensive record of the archaeological activities, which commenced in 1992, has yet been published. For contemporary descriptions see Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 197, 203-6; William of Tyre, *Chronicon* 21.25 (26), ed. Huygens, 2:997, trans. Babcock and Krey, 2:436-37; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:264-65. Contrary to the assertions of William of Tyre (21.27, 30), the castle was never completed, as confirmed by archaeological evidence, Ellenblum, et al., "Crusader Castle," p. 305; Boas, *Crusader Archaeology*, p. 118-20.

[424] Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 203. Cf. Ibn al-Athir, *al-Kamil*, trans. Richards, 2:265.

[425] *De expugatione terrae sanctae*, ed. Stevenson, pp. 243-44, trans. Brundage, p. 160.

[426] Pers. cor. with excavators Adrian Boas and Kate Raphael, May 2013. For a survey of the numerous arrowheads that have been found see, Raphael, "A Thousand Arrowheads," pp. 252-61. For general excavations, see Ellenblum, et al., "Crusader Castle," pp. 303-6.

[427] For Saladin's campaign against Jacob's Ford and the siege of the castle, see Abu Shama, *Kitab al-Raudatain*, RHC Or , pp. 195-205; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:264-66; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 59-61; William of Tyre, *Chronicon* 21.26.28 (27-29), ed. Huygens, 2:998-1,002, trans. Babcock and Krey, 2:440-43. See also Benvenisti, *The Crusaders*, pp. 304-5; Boas, *Crusader Archaeology*, pp. 118-19; Ellenblum, *Crusader Castles*, pp. 270-73.

artillery was being stockpiled in Damascus before Nur al-Din established himself there and it is possible that the engines that 'Imad al-Din implies Saladin intended to use at Jacob's Ford were drawn from this arsenal.[428] The only other materials that are mentioned in relation to artillery are those that were gathered from around Safed, suggesting that the Muslim army had no intention of building any new stone-throwers on site.

The ways in which artillery was employed by the end of the 1170s are thus varied. While there is evidence that the Sicilian force that attacked Alexandria in 1174 did so with the aid of imported counterweight trebuchets, the Frankish forces that besieged Harim in 1177 did so with locally constructed artillery that may have been little more advanced than that used during the First Crusade. At Jacob's Ford, it would appear that Saladin had initially intended to use prefabricated artillery, but with siege efforts proceeding at a good pace, he opted neither to make use of these nor to build lighter engines from locally sourced materials. Despite what appears to be the growing importance of artillery, Saladin made no use of any when he attacked Beirut a few years later.

Beirut: 1182

William of Tyre, explicitly states that Saladin's forces did not bring artillery with them ahead of the assault launched against Beirut in 1182, nor does he mention its subsequent construction. Instead, archers were relied upon to cover ongoing sapping efforts. Frontal assaults were undertaken in relays for three days until a Frankish fleet arrived to break the siege.[429] Unlike the scenario at Jacob's Ford in 1179, the topography between a Muslim staging point, such as Banyas, and Beirut would have posed quite a challenge. Accordingly, Saladin may have opted to travel light and maximise the mobility of his forces. This may also reflect the policy that Saladin had employed in 1179, when he appears to have kept his baggage safely on the far side of the Jordan until he had successfully defeated the army of Jerusalem. As a third possibility, Saladin may have been sufficiently impressed by his miners and assault forces at Jacob's Ford to forgo the troubles of moving artillery with the army.

[428] Fulton, "Development of Prefabricated Artillery," pp. 58-59.
[429] William of Tyre, *Chronicon* 22.18-19 (17-18), ed. Huygens, 2:1032-36, trans. Babcock and Krey, 2:475-79. Cf. Baha' al-Din, *al-Nawadir*, trans. Richards, p. 57; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 223; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:283.

Whatever Saladin's motives were for not bringing artillery to Beirut, his decision not to construct even light engines upon his arrival is significant. William of Tyre's remark that the Franks built siege engines and ladders with wood harvested from the pine groves around Beirut when they besieged the city in 1110, a detail not found in Fulcher of Chartres' earlier account, suggests that there were appropriate sources of timber surrounding the city at the time of Saladin's siege.[430] In 1184, a confirmation of the bishop's right to take beams from a nearby pine forest leaves no doubt that suitable timber for the construction of traction, if not counterweight, engines was at hand.[431]

The fortifications of Beirut would have posed a much more significant obstacle than those of the incomplete castle at Jacob's Ford. Although William of Tyre claims that sappers attempted to undermine the town walls, Saladin likely realised that his chances of taking the city before the forces of Jerusalem could arrive would be slim so focused his efforts on waves of consecutive frontal assaults. Revealingly, the Muslim sources treat this attack as a far less significant episode than does William of Tyre. Despite the absence of stone-throwers at Beirut, Saladin's competence with artillery is confirmed by his campaigns beyond the Euphrates soon after.

<u>Mosul and Amida: 1182-83</u>

Mosul was the most significant city on the upper Tigris and its defences reflected this. With Saladin's approach, Izz al-Din of Mosul had artillery prepared for the city's defence before the siege was opened in November 1182. According to Ibn al-Athir, Saladin's nephew, Taqi al-Din, lobbied that they should erect a large stone-thrower against the city, to which Saladin responded, "No trebuchet can be set up against a city like this. If we erect it, they will seize it." Rejecting this, Taqi al-Din set one up anyway, only to have it targeted by nine alleged defensive stone-throwers before it was seized in a sally.[432] The account reveals little of the power of Saladin's artillery, apart from the possibility that Taqi al-Din's engine may have been slightly more significant than the norm, though this is not stated.

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[430] William of Tyre, *Chronicon* 11.13, ed. Huygens, 1:515-16, trans. Babcock and Krey, 1:484-86; Fulcher of Chartres, *Historia Hierosolymitana* 2.42.1-2, ed. Hagenmeyer, pp. 534-36, trans. Ryan, pp. 196-97.

[431] Pringle, *Churches*, no. 42, 1:115.

[432] Ibn al-Athir, *al-Kamil*, trans. Richards, 2:285-87. Cf. Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 57-58. The Mosuli forces were kept within the city during most of this siege, rather than engaging the enemy in the field as typically occurred at the sieges of Aleppo and Damascus in the twelfth century.

Although absent at the time, Ibn al-Athir was a resident of Mosul and would have been familiar with the provisions for its defence. His account confirms the widespread use of defensive artillery throughout the Near and Middle East but also touches on the difficulties of disabling offensive artillery with such engines. Unfortunately, Baha' al-Din, who left the city to gather support from Baghdad only days before Saladin's arrival, leaves very few details of this siege in his chronicle of events. After moving on from Mosul, Saladin erected artillery against Amida (Diyar Bakr) in early 1183, where it was once more used to support sapping efforts.[433]

Up to this point, one geographic region has been deliberately neglected in this investigation of twelfth-century artillery and its usage. Because Saladin devoted so much attention to Transjordan during the 1170s and especially the 1180s, it will be explored outside the general chronology.

Transjordan

At the start of the twelfth century, Baldwin I had extended Frankish interests into Transjordan ahead of his coronation.[434] Under the aggressive leadership of Reynald of Châtillon from 1176/77, the region became a critical battleground between Egypt and Syria. The Franks had erected fortifications along the eastern ridge of the Wadi Araba from at least the second decade of the twelfth century and by the 1170s, the mighty castles of Montreal and Kerak anchored Frankish interests in this region.[435] But what had once

[433] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 58; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:287; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 71. Baha' al-Din claims that the siege lasted eight days while Ibn al-Athir places its length at around fourteen days. The impressive remains of the basalt walls are some of the best preserved medieval defences in the region. See also Chevedden, "Invention," pp. 93-94.

[434] Fulcher of Chartres, *Historia Hierosolymitana* 2.4, ed. Hagenmeyer, pp. 370-75, trans. Ryan, pp. 143-47; *Historia Nicaena* 64, RHC Oc 5, pp. 177-78. Cf. Albert of Aachen, *Historia Ierosolimitana* 7.41-43, ed. and trans. Edgington, pp. 546-51. Baldwin I followed up this initial reconnaissance in force with another in 1107, intercepting a Damascene force around Wadi Musa (Petra). In 1112/13, he returned to the region to prey on the caravan traffic between Cairo and Damascus, Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 81-82, 130-31; Ibn al-Athir, *al-Kamil*, trans. Richards, 1:146, 164; Albert of Aachen, *Historia Ierosolimitana* 10.29-31, 12.8, ed. and trans. Edgington, pp. 744-47, 834-35. For the lordship and its lords, see Richard, *The Latin Kingdom of Jerusalem*, pp. 88, 95; Tibble, *Monarchy and Lordships*, pp. 29-36, 83-84. Cf. Riley-Smith, *The Crusades*, pp. 96-99.

[435] In the extreme south, a castle was built as an outpost on the so called Ile de Graye (Pharaoh's Island, Jazirat Fara'un) at the north end of the Gulf of Aqaba, probably in the 1160s. In the Petra valley, al-Habis and Li Vaux Moise (Wadi Musa) were built by the Franks, overlooking the Nabataean-Roman basin and a few kilometres beyond the siq respectively. Montreal, situated between Petra and the Dead Sea, was the

been a frontier area between the independent powers of Jerusalem, Cairo and Damascus was transformed into a vital corridor between the two geographic power-centres of Saladin's empire following his unification of Egypt and Syria. The increased importance of this region led Kerak to become the most besieged castle of the kingdom of Jerusalem in the twelfth century, having enjoyed relative peace until 1170.

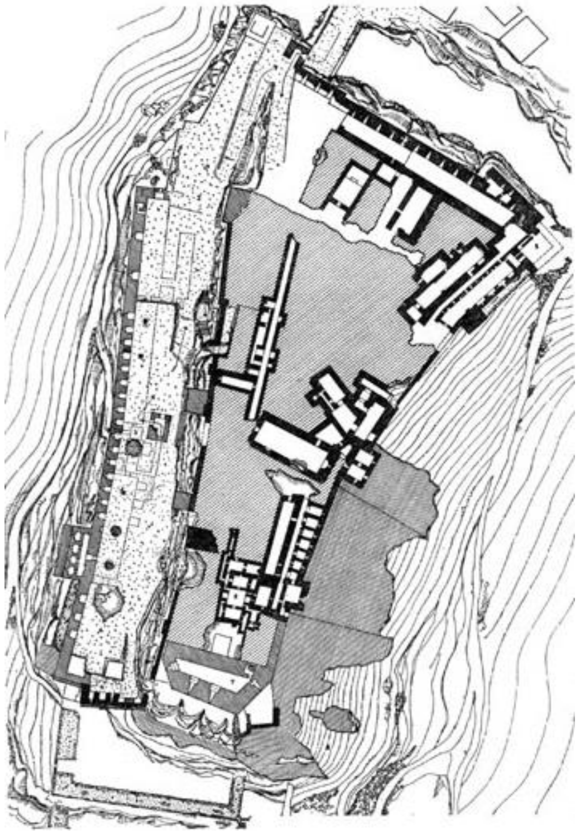
Defences of Kerak

The fortifications of Kerak are not very sophisticated. Its towers do not protrude far from the line of the adjoining curtain walls and its Frankish masonry, composed of hard volcanic stone, appears poor compared to the fine limestone masonry of later Muslim additions and rebuilding. Kerak's strength is its position and solidity. High on a ridge, the castle is secured along its east and west flanks by a steep gradient. To the north, the castle is separated from the town by a fosse 20-30 m wide and perhaps once as deep as sixty cubits (32.4 m).[436] Behind the fosse is a 135 m long wall, up to 5 m thick, rising from the rock-cut scarp of the fosse and secured at each end by a slight projection akin to a tower, each with a postern on its recessed inner flank. To the south, the castle is separated from the remainder of the ridge by a dip in the topography, augmented with a rock-cut by the Franks. The original Frankish work at this end of the castle has been mostly obscured by the addition of the large Mamluk donjon. Beyond the southern masonry defences is an external open cistern, both a source of water and a defensive obstacle. Along the western

first major castle built in the area. From about 1142, Montreal as overshadowed by the equally impressive castle of Kerak, just east of the southern end of the salt lake and much closer to Jerusalem. For the Ile de Graye and Aqaba, see De Meulemeester and Pringle, "Al-'Aqaba Castle," pp. 97-102; Pringle, "The Castle of Ayla," pp. 333-53; Pringle, *Secular Buildings*, no. P5, p. 113; Kennedy, C*rusader Castles*, p. 30; Deschamps, *Les Châteaux des Croisés*, 2:44; Rey, *Architecture militaire*, p. 276. For al-Habis see Pringle, *Secular Buildings*, no. 97, p. 49; Marino, "The Crusader Settlement in Petra," pp. 4-5; Kennedy, C*rusader Castles*, pp. 25, 29-30. For Li Vaux Moise see Pringle, *Secular Buildings*, no. 230, pp. 105-6; Kennedy, C*rusader Castles*, pp. 25-27; Vannini and Tonghini, "Medieval Petra," pp. 371-84. For Montreal, see Faucherre, " La fortresse de Shawbak," pp. 43-66; Pringle, *Churches*, 2:304-14; Pringle, *Secular Buildings*, no. 157, pp. 75-76; Brown, "Summary Report"; Deschamps, *Les Châteaux des Croisés*, 2:43-45. Cf. Fulcher of Chartres, *Historia Hierosolymitana* 2.55, ed. Hagenmeyer, pp. 592-93, trans. Ryan, p. 215; Albert of Aachen, *Historia Ierosolimitana* 12.22, ed. and trans. Edgington, pp. 858-59; *Historia Nicaena* 76, RHC Oc 5, pp. 181-82; William of Tyre, *Chronicon* 11.29, ed. Huygens, 1:542, trans. Babcock and Krey, 1:513; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:65. For Kerak, see Deschamps, *Les Châteaux des Croisés*, 2:35-98; Müller-Wiener, *Castles of the Crusaders*, pp. 47-48; Pringle, *Churches*, 1:286-94; Pringle, *Secular Buildings*, no. 124, pp. 59-60; Brown, "Excavations"; Kennedy, C*rusader Castles*, pp. 45-50. Cf. William of Tyre, *Chronicon* 15.21, 22.28, ed. Huygens, 2:703-4, 1056, trans. Babcock and Krey, 2:127, 499; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:50-51.

[436] Ibn al-Athir, *al-Kamil*, trans. Richards, 2:300; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:51. Abu'l-Fida' claims that it was fifty cubits deep, Abu'l-Fida', *al-Mukhtasar*, trans. Holt, pp. 47-48.

Kerak: castle, plan (from Müller-Wiener)



side of the castle there appears to have been a lower bailey, though this too has been obscured by subsequent Muslim rebuilding.

Although simple in design, Kerak was keenly planned. The only practical position from which to assail the castle was from the town, across the castle's northern fosse. The present wall facing this front, presumably dating to the mid-twelfth century, is thick and bristling with three levels of embrasures below the battlements. The castle was thus almost impossible to assail directly provided the northern ditch remained unobstructed. Although any town defences constructed by the Franks appear to have vanished in the wake of the Mamluk rebuilding, the sources, and simple defensive necessity, suggest that the town was fortified to at least some extent during the twelfth century.

Early Sieges: 1170-73

Kerak was besieged no less than five times between 1170 and 1188.[437] Only months after the Frankish-Byzantine attack on Damietta in 1169, Nur al-Din led a screening manoeuvre into Transjordan in early 1170, shielding the movement of a large contingent of supplies, merchants and members of Saladin's family heading to join him in newly Abbasid Egypt. Kerak appears to have been besieged at this point and 'Imad al-Din claims that two stone-throwers bombarded the castle for four days before the siege was lifted with the approach of Frankish forces.[438] In 1171, Nur al-Din attempted to coordinate a

[437] These took place in 1170, 1173, 1183, 1184 and 1187-88.
[438] Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 153-54. See also Ibn al-Athir, *al-Kamil*, trans. Richards, 2:184. Cf. Baha' al-Din, *al-Nawadir*, trans. Richards, p. 46; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:51.

joint assault on Montreal with Saladin but mutual mistrust led to its failure,[439] while in 1173 Saladin led the first assault on Kerak from the direction of Egypt.[440]

In spring 1182, Saladin moved a force into Transjordan to cover the movement of troops out of Egypt that he intended to use later that year in Mesopotamia. Although no siege appears to have taken place, al-Maqrizi notes that mangonels were sent to the army just before it left Egypt.[441] The following year, Kerak endured its first widely documented and truly concerted siege attempt during the wedding of Humphrey III of Toron and Isabella of Jerusalem,[442] the first of three sieges in five years.

Kerak: 1183

Saladin left Damascus on 22 October 1183, ordering his brother, al-'Adil, to meet him at Kerak. The latter was to bring Egyptian forces to aid siege efforts while simultaneously ferrying his family and treasury out of Egypt to his new post in Aleppo.[443] The Egyptian forces arrived on 22 November, after the siege had already begun.

Upon its arrival, Saladin's main force established a blockade and began to set up artillery. These engines may have been erected initially against the town, which Reynald of Châtillon attempted to defend, but after forcing an entry they were set up to assail the north face of the castle from inside the town. In their panic to reach the castle, the fleeing refugees from the town tore down the bridge over the northern fosse. Although this firmly halted the besiegers, it also prevented the Franks from launching any sorties and provided Saladin with the security to erect his artillery as close to the fosse as he liked, having only to contend with the missiles and projectiles thrown from the castle.

[439] Ibn al-Athir, *al-Kamil*, trans. Richards, 2:198-200; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 38, 41-43.
[440] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 48; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:213-14; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 156-57; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:51; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 43; William of Tyre, *Chronicon* 20.26-28, ed. Huygens, 2:948-52, trans. Babcock and Krey, 2:386-90. William of Tyre's descriptions of events in Transjordan are rarely clear and his mistakes when discussing imply that he never visited the castle, rendering his descriptions of particulars suspect. He claims that invasions took place in the eighth, ninth and tenth years of Amalric's reign (from 1170 to 1174), but they appear to be skewed within the chronology. This appears to explain why Richard dated William's account of the 1170 siege of Kerak to 1173, the latter would require Saladin to be both besieging Kerak and relieving Alexandria from Cairo in July 1174, Richard, *The Latin Kingdom of Jerusalem*, p. 51.
[441] al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 67. See also Hamilton, *The Leper King*, p. 172.
[442] Hamilton has suggested that Saladin deliberately planned the siege to take place while the castle was filled with wedding guests, Hamilton, "The Elephant of Christ," p. 105.
[443] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 62; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 248; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:297; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 71-72.

William of Tyre states that Saladin brought siege equipment with him from Damascus,[444] which probably consisted of prefabricated artillery. Ibn al-Athir claims that Saladin erected seven stone-throwers and William of Tyre gives the figure of eight: six within the town and two without at a place known as 'Obelet'.[445] Deschamps has suggested that this secondary position was on the spur to the south and that the engines placed here targeted the castle's southern defences, now dominated by the Mamluk donjon.[446] Although this appears to be the only sensible secondary position, at a distance of about 115 m, it is questionable whether contemporary artillery could have had any kind of effect from here.[447]

The bombardment from the town was clearly intense, allowing the besiegers to slaughter the Frankish livestock that had been gathered in the northern fosse. However, the physical effects of this artillery barrage seem to have been minimal. Undoubtedly psychologically exhausting and threatening to any who exposed themselves along the parapet, at no point do these engines seem to have endangered the integrity of the stronghold's fortifications. Either critically or apologetically, Ibn al-Athir claims that Saladin did not expect the main Frankish army to allow him to besiege Kerak for very long so had intentionally not brought a sufficient number of engines for a long siege. This observation is peculiar when considering that this is the largest number of trebuchets given by Ibn al-Athir at a single siege since the Fatimid siege of Jerusalem in 1099. Saladin's lack of progress after a month of uninterrupted bombardment is revealing. Although he may have been employing prefabricated artillery, even these were evidently fairly light. Whether these were traction trebuchet or small counterweight engines, they were certainly not breaching engines.

The defenders attempted to build their own stone-thrower inside the castle, but this was soon put out of action by the skilled crews working the Muslim artillery. Thus it was left to little more than the static strength of Kerak's fortifications to endure the Muslim artillery barrage, while those within hoped that the masonry over their heads was

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444 William of Tyre, *Chronicon* 22.29 (28), ed. Huygens, 2:1,055-57, trans. Babcock and Krey, 2:498-501.

445 Ibn al-Athir, *al-Kamil*, trans. Richards, 2:297-98; William of Tyre, *Chronicon* 22.31 (30), ed. Huygens, 2:1,059, trans. Babcock and Krey, 2:503.

446 Deschamps, *Les Châteaux des Croisés*, 2:64.

447 The Ernoul account states that Saladin spared the tower in which the married couple were staying from the barrage of his *perrieres* and *mangonniaus*, *Ernoul* 9, ed. Mas Latrie, pp. 103-4. The context would suggest that this tower was in range of the attacking artillery; however, the author provides no details of where Saladin's engines were placed or which towers were in range, drawing into question the reliability of this anecdote.

strong enough to withstand the impact of any projectiles that sailed over the walls and struck the unfortified buildings within the enceinte.

The siege was lifted in early December 1183 when relief arrived under Baldwin IV of Jerusalem. With Egypt stripped of its defenders, brought out by al-'Adil, Saladin sent his nephew Taqi al-Din 'Umar there while he turned his forces towards Damascus, giving Kerak a short period of respite.[448]

Kerak: 1184

Saladin returned to Kerak around the start of August 1184 and the Islamic sources clearly convey the impression that he once more made extensive use of artillery.[449] William of Tyre omits any mention of this episode but Baldwin IV notes the use of *petrariae* in a letter written soon after the siege.[450] Having failed the year before, there is little reason to doubt that Saladin brought his best and most powerful machines on this occasion.

'Imad al-Din appears to suggest that the defenders again made an effort to defend the town, against which Saladin initially directed nine trebuchets. He claims that the engines destroyed part of a wall, leaving only the fosse of the castle to overcome.[451] Due to the source's poetic writing style, it cannot be said with certainty that he intended this wall to be part of the town curtain rather than the north wall of the castle; however, Ibn al-Athir and Ibn Shaddad preferred the former interpretation in their accounts.[452] 'Imad al-Din places this artillery damage early in the siege, before efforts were underway to fill the castle's northern fosse by 17 August. However, Baha' al-Din appears to imply that Saladin did not erect his artillery until 23 August, when he was joined by the Mesopotamian contingents of his army, and al-Maqrizi claims artillery was not used until

[448] William of Tyre, *Chronicon* 22.29 (28), 31 (30), ed. Huygens, 2:1,055-57, 1,059-60, trans. Babcock and Krey, 2:498-501, 503-4; *Ernoul* 8, 9, ed. Mas Latrie, pp. 80-82, 102-6; Baha' al-Din, *al-Nawadir*, trans. Richards, p. 62; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:297-98; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 248; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:52; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 71-72.

[449] Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 249-56; Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 64-65; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:299-300; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:52; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 74. Cf. Ibn Jubayr, *Rihla*, trans. Broadhurst, pp. 300-1, 313-14.

[450] Letter of Baldwin IV to a Frankish delegation in Europe, in Ralph of Diceto, *Ymagines historiarum*, ed. Stubbs, pp. 27-28.

[451] Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 254.

[452] Ibn al-Athir, *al-Kamil*, trans. Richards, 2:300; Ibn Shaddad, in Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:52.

3 September.[453] It is thus unclear how long these engines were in use before Frankish relief arrived and the siege was lifted around 4 September.

There are presently no signs of damage to indicate that the northern wall of the castle was significantly damaged during this siege, or that of the previous year, while the Frankish town walls and gates have since disappeared, preventing an assessment of any repair work. Although the weakness of these outer defences might have encouraged their rebuilding, it still seems unlikely that late-twelfth-century artillery could have inflicted sufficient damage to be credited with allowing assailing forces to take the town, especially given the implicitly short period of time that they were assailed.

When the sources are read collectively, it seems that Saladin directed most of his efforts towards filling the northern fosse and constructing covered ways to assist in this operation. Most accounts present the Muslim artillery as assisting these efforts. It is in the freer language of the letters preserved by Abu Shama, that the destructive effect of the attacking artillery is most embellished. Despite the prevalent imagery of general destruction, at times these letters definitively refer to artillery targeting the castle's parapet and its Frankish defenders.[454] While the mass of the northern wall displays no evidence of obvious impact signatures or significant repairs, this cannot be said of the parapet, or what remains of it. This is not conclusive evidence that the castle's northern battlements were damaged during the siege in 1184, as damage and repairs carried out here could date to a number of subsequent episodes, but the lack of discernible destruction below this level suggest that this was where artillery fire was concentrated.[455]

In contrast to the siege of 1183, most of the sources draw attention to the active defence mounted by the defenders. The garrison, which had apparently constructed defensive artillery since the last siege, showered the Muslims attempting to fill the fosse with stones as well as arrows. The limited power of these engines is indicated by their inability break through the improvised mud-brick coverings built by the besiegers to protect their path to the fosse.

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[453] Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 64-65; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 254; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 74. See also Ibn al-Athir, *al-Kamil*, trans. Richards, 2:300; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:52. Cf. Deschamps, *Les Châteaux des Croisés*, 2:66-68.
[454] Abu Shama, *Kitab al-Raudatain*, RHC Or 4 pp. 251-55.
[455] Brown, "Excavations," p. 290.

Kerak and Counterweight Artillery

Given the frequency with which Kerak was besieged through the 1170s and 1180s, a number of historians have discussed some of these sieges in their assessments of the power of late-twelfth-century artillery. Ronnie Ellenblum has suggested that the brevity of the siege in 1170, and 'Imad al-Din's claim that only two engines were used, is reflective of a wider policy whereby Muslim forces were beginning to integrate prefabricated heavy artillery.[456] But it is unclear how the brevity of an unsuccessful siege supports the presence of particularly powerful siege engines, especially when most sources do not mention the use of artillery. Such a theory also fails to address the sieges of 1183 and 1184, where many more engines were used with equally little physical effect. Furthermore, if Saladin abandoned his artillery when he lifted the siege in 1183, as is suggested by William of Tyre,[457] this suggests that it was less valuable to him than the mobility that he gained without it, allowing him to raid the southern parts of the kingdom of Jerusalem and burn Nablus before returning east of the Jordan.

What has hitherto been neglected by historians is a simple investigation of the architectural remains. The outer face of Kerak's northern wall reveals neither notable

Kerak: north wall of the castle, from the northwest (author)

[456] Ellenblum, *Crusader Castles*, p. 258.
[457] William of Tyre, *Chronicon* 22.31 (30), ed. Huygens, pp. 1059-60, trans. Babcock and Krey, 2:504.

blemishes nor subsequent repairs below the level of the ramparts. No trace of the bombardments in the 1180s is discernible, even though the attacking artillery may have been as close as 30 m in 1183.[458] While the rough masonry could easily disguise impact signatures inflicted by traction trebuchets, if heavier counterweight engines were employed with the intention of damaging the structure of the wall, there should be evidence of this. Rather than this wall, it is the fosse in front of it that was considered to be the more formidable obstacle – so long as the castle's foundations remained beyond the reach of the Muslim miners on the far side of the fosse, the castle and its defenders were secure. Whether traction- or counterweight-powered, prefabricated or locally built, the inability of Saladin's artillery to make an impression on Kerak's defences following so many sieges clearly reveals the limited power of the artillery brought against them.

Kerak: 1187

The last siege of Frankish Kerak began in 1187. As part of the multi-directional offensive that ultimately culminated in the battle of Hattin, Saladin took a force to Bosra that spring to protect the returning pilgrim caravans. This force then moved into Transjordan where it was joined by contingents from Egypt. A part of this force settled down to invest Kerak while the remainder raided throughout the Frankish lordship.[459] Having travelled to Bosra without baggage, it seems unlikely that Saladin made use of artillery or even intended to press the siege to an aggressive conclusion. Although it is possible that the Egyptian contingent might have brought siege equipment, there is no evidence of this. Saladin appears to have appreciated the relative resilience of Kerak to acute siege tactics and changed his strategy, content to allow the garrison to starve itself to the point of capitulation if events to the north failed to bring about a greater advantage there.[460]

[458] The castle was subsequently besieged at least twice in the thirteenth century, in 1246 by Egyptian forces and 1286 by a Mamluk detachment, though there appear to be no indications that artillery was used on either occasion, Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, p. 80; Maqrizi, trans. Broadhurst, pp. 281-82, trans. Quatrèmer, 2.1:87-88; Abu'l-Fida', *al-Mukhtasar*, trans. Holt, p. 13.

[459] Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 71-72; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 261-62; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:318-19; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 82; *Eracles* 23.54, RHC Oc 2, p. 81.

[460] Since his devastating defeat at Montgisard in 1177, Saladin had been seeking a decisive battle with the kingdom of Jerusalem, but failed to lure the numerically inferior Frankish army into an ideal position despite repeated incursions into Galilee and Transjordan. These campaigns had, however, reinforced the advantages of pressure along multiple fronts at the same time.

Most contemporary references to twelfth-century artillery are far from detailed. From the Frankish perspective, this mirrors similar trends in Europe: using ambiguous terms such as *machinae* or only vaguely identifying the presence of artillery, with terms like *petrariae*, without describing how it was employed. However, the mundane manner in which such engines are noted throughout the century clearly indicates that these were familiar machines, a point plainly made by the number of occasions in which certain sources, such as Albert of Aachen, Matthew of Edessa and William of Tyre, claim that artillery was used. From the Muslim perspective, references to artillery in Ibn al-Qalanisi's history increase from about 1138. This probably reflects, to some degree, the author's increased exposure to such engines, perhaps associated with the increasing pressure that Zanki was applying towards Damascus. A similar pattern can be found in Ibn al-Athir's record of events, in which artillery is referenced at only nine sieges in the Near and Middle East between 1100 and 1159 but is then found on no less than ten occasions between 1160 and 1177. This dramatic increase, which corresponds with the height of Nur al-Din's power and Saladin's early career, may be due in part to the source's use of the lost portions of 'Imad al-Din's *al-Barq al-Shami*. Ibn al-Athir then mentions artillery in sixteen places during the 1180s, accompanying Saladin's rise to pre-eminence and the attention this received in the various histories that he used. The increasing number of references to artillery suggests that these engines were gaining greater importance. By examining the events surrounding the Third Crusade, it is possible to gain an appreciation of how much these engines had developed since the First Crusade and a better sense of how they were being employed by the end of the twelfth century.

5. Artillery and the Third Crusade

Power and Value (1187-1192)

The Consequences of Hattin

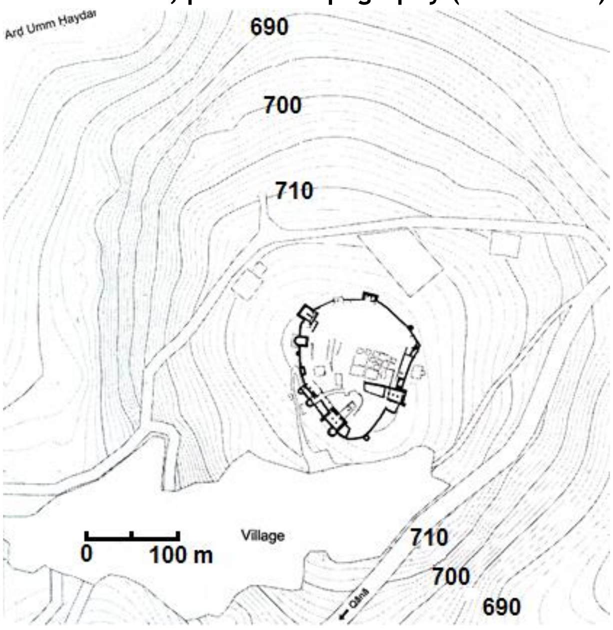
When Saladin crossed the Jordan in 1187, his campaign objectives may have been far more like those that he had had when he invaded Galilee in 1179 and 1183 than is often considered.[461] Saladin most likely left his siege engines east of the Jordan while he provoked the Frankish army into action by besieging Tiberias in early July. The only Muslim source that indicates that artillery might have been used at Tiberias is 'Imad al-Din; however, his choice of words seems to be influenced by the rhyming style of his writing.[462] The term he uses, *hajjarun*, can be understood as 'stoneworkers', which applied to sappers as well as those who shaped artillery ammunition.[463] Mining and a frontal assault, rather than artillery, appear to have been the decisive factors that allowed the Muslims to take the town in a single day.[464]

[461] For the 1179 campaign, William of Tyre, *Chronicon* 21.27-29 (28-30), ed. Huygens, 2:1,000-4, trans. Babcock and Krey, 2:440-45; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 198-206; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:264-65; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 59-60. For the 1183 campaign, see William of Tyre, *Chronicon* 22.26-28 (25-27), ed. Huygens, 2:1,048-54, trans. Babcock and Krey, 2:492-98; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 242-48; Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 60-61; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:297; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 72.

[462] See Fulton, "Development of Prefabricated Artillery," pp. 58-59.

[463] See Khamisy, "Some Notes on Ayyubid and Mamluk Military Terms," pp. 73-92. See also Amitai, "Foot Soldiers," p. 236. For the siege of Tiberias, see 'Imad al-Din, *al-Fath*, trans. Massé, p. 24. For the Arabic, see Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 264. Cf. Baha' al-Din, *al-Nawadir*, trans. Richards, p. 73; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:320-21; Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 58; *Eracles* 23.31, RHC Oc 2, pp. 47-48.

[464] For the defences of Tiberias, see Pringle, "Town Defences," pp. 94-95; Stepansky, "Das kreuzfahrerzeitliche Tiberias," pp. 384-95; Stepansky, "Tiberias, the Courtyard of the Jews"; Stepansky, "Tiberias, Map Survey."



Toron: castle, plan and topography (after Piana)

It is unclear whether Saladin was moving with his artillery when he arrived at Acre on 8 July and received the town's surrender on the following day.[465] Baha' al-Din and 'Imad al-Din note its use soon after at Toron but it is unclear where these engines came from.[466] It is possible that they were brought by Taqi al-Din or Saladin via Acre, or that an otherwise unknown party brought them from elsewhere, or even that they were built on site before the garrison surrendered on 26 July.[467] Saladin does not appear to have employed any engines during his subsequent push up the coast, during which he took Sidon, Beirut and Jubayl (Byblos), nor during the foray into Palestine that gained him Ramla, Hebron and Bethlehem. Likewise, the Muslim sources do not mention artillery during al-'Adil's acquisition of Mirabel and Jaffa. The contemporary Frankish author of the *De expugnatione terrae sanctae*, however, notes the use of *machinae* at the former.[468] The two Muslim armies united on 23 August before investing Ascalon.

<u>Ascalon: 1187</u>

Saladin was likely impressed by the defences of Tyre, having passed them twice in less than a month, and probably regarded Ascalon as an easier target; possessing the latter would also facilitate the movement of troops and supplies from Egypt to Palestine. The Muslims encamped outside Ascalon in late August and, once Saladin's offer to free Guy

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[465] 'Imad al-Din, *al-Fath*, trans. Massé, pp. 31-33; Baha' al-Din, *al-Nawadir*, trans. Richards, p. 75; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:324-26. See also Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 58.

[466] 'Imad al-Din, *al-Fath*, trans. Massé, pp. 37-38; Baha' al-Din, *al-Nawadir*, trans. Richards, p. 76.

[467] 'Imad al-Din, *al-Fath*, trans. Massé, pp. 37-39; Baha' al-Din, *al-Nawadir*, trans. Richards, p. 76; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:326-27. Baha' al-Din's account is the exception to the popular narrative, stating the castle fell to assault and its steadfast defenders were led into captivity. For a nineteenth-century description of the castle see Conder and Kitchener, *Survey of Western Palestine*, 1:133-35, for a more recent report, see Piana, "The Crusader Castle of Toron," pp. 177-91.

[468] *De expugnatione terrae sanctae*, ed. Stevenson, p. 229; 'Imad al-Din, *al-Fath*, trans. Massé, p. 33; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:326; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 83. For an examination of the section of the *Libellus de expugnatione de terrae sanctae per Saladinum* dealing with the events of 1187, a brief discussion of its author and its relation to the Ernoul and *Eracles* continuations of William of Tyre's account, see Kane, "Wolf's Hair."

of Lusignan in exchange for the city's surrender was rejected, he erected artillery.[469] The sudden appearance of these engines and their widespread notice is peculiar. It is possible that the appearance of artillery at this point reflects the greater significance of this siege, during which the defenders put up a stiff resistance initially, that the engines employed here were more impressive than others used earlier, or simply that such engines were not often used by Saladin and his army in July 1187.

Despite the number of sources that mention their use, only a few portray them as exceptional. A letter sent by Saladin that is preserved in the *History of the Patriarchs*, presumably one of many sent out declaring his latest victory, presents the besieging engines as particularly destructive. It states that he ordered his artillery set up on 23 August, that they were ready on 25 August and only one day later they opened a breach in a certain large bastion.[470] When considering that the letters sent out after the siege of Kerak in 1184 also appear to exaggerate the power of Saladin's artillery, caution should be taken before concluding that these engines were particularly powerful. The widespread notice of artillery in the Muslim sources is perhaps related to the spread of letters such as this. Whatever the case, after a siege of two weeks, Ascalon's defenders surrendered on 5 September. No mention of artillery is made during the subsequent acquisition of many smaller towns and strongholds as contingents of the Muslim army spread out across Palestine before Jerusalem was besieged.

Jerusalem: 1187

The defences of Jerusalem that Saladin encountered were similar to those faced by the Franks in 1099.[471] On 20 September 1187, Saladin encamped his army to the west of the city, where Raymond of St Gilles had first positioned his forces eighty-eight years earlier. From this point, Saladin's archers began to discharge a shower of suppressing fire that would continue throughout the siege. After surveying the city's defences, Saladin moved

[469] Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 76-77; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 97, 100; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 312-13; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:329–30; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 84; *De expugnatione terrae sanctae*, ed. Stevenson, pp. 236-37; *Itinerarium* 1.8, ed. Stubbs, pp. 19-20, trans. Nicholson, p. 37; *History of the Patriarchs*, trans. Khater and Khs-Burmester, 3.2:128-31. This is the first time that Ibn al-Athir clearly states that artillery was used by a component of Saladin's army since it crossed the Jordan months earlier.

[470] *History of the Patriarchs*, trans. Khater and Khs-Burmester, 3.2:131.

[471] Most Frankish fortification efforts at Jerusalem undertaken between 1099 and 1187 appear to have been repairs rather than more extensive rebuilding projects. For example, William of Tyre, *Chronicon* 21.24 (25), ed. Huygens, 2:996, trans. Babcock and Krey, 2:436. See also Boas, *Jerusalem*, p. 44; Pringle, "Town Defences," pp. 79-80.

the bulk of his army to the north on 25 September, having decided to focus his assault east of St Stephen's (Damascus) Gate, as the crusaders had in 1099. The space and elevation of the ridges running northwards from the city would have provided Saladin with plenty of options when positioning his artillery.

Saladin began to set up his artillery on the night of 25 September and by the following morning it was operational.[472] Although artillery is included in all of the principal sources,[473] 'Imad al-Din's account is perhaps the most evocative:

> [Saladin] installa les machines de guerre, fit tomber les calamités comme l'eau tombe des nuages...Les assises des murailles et les dentelures de leurs créneaux furent détruites et écrêtées par les pierres qui sortaient des machines de guerre. On eût dit que les mangonneaux devenaient fous tandis qu'on les manœuvrait, ils étaient comme des braves qu'on ne peut égaler; ils semblaient des monts entraînés par des cordes; on eût dit des vols de sauterelles actionnés par les hommes, des mères d'infortune et de mort, des femmes grosses qui enfantaient les calmités; nulle protection contre leurs pierres; nulle sécurité près d'elles, mème pour qui prenait garde; leurs projectiles ne progressaient qu'accompagnés du danger; leur passage ne créait qu'amertumes pour les humains. Que d'étoiles s'abattaient du haut de leur ciel! Que de rochers jaillissaient de leur emplacement! Que de tisons se répandaient de leurs étincelles! Rien de comparable aux ravages causés par leurs proches à la précision de leurs coups subits, aux tractions de leurs cordes. Sans cesse, elles arrachaient tout au moyen de leur frondes, battaient de toute leur charpente, tiraient avec entrain sur leur cordes, frappaient, démolissaient, renversaient, fendaient, puisaient à leur réserve de pierres, préparaient le mal qu'elles allaient faire, dérangeaient l'assemblage des pierres du rempart au moyen des roches lancées l'une après l'autre, détruisaient la cohésion des édifices dont elles disloquaient, déchaussaient et disjoignaient les assises en atteignant leurs fondements, déliaient les clefs de voûte en les prenants sous l'effet de leurs cordes, épuisaient les citernes en buvant à leur creux.
>
> Bref, laissant les remparts à l'état de résidus dont les défenseurs étaient repoussés, l'ennemi se trouva déconfit, son organisation, détruite; le fossé fut franchi; les troupes furent lancées en avant...[474]

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[472] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 77; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 326-27; *De expugnatione terrae sanctae*, ed. Stevenson, pp. 241-43, trans. Brundage, pp. 159-60; Ernoul, *Chronique* 18, ed. de Mas Latrie, pp. 211-14; *Eracles* 23.55, RHC Oc 2, pp. 82-83.

[473] 'Imad al-Din, *al-Fath*, trans. Massé, pp. 44-46; Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 77-78; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 326-30; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:330-33; *De expugnatione terrae sanctae*, ed. Stevenson, pp. 241-46, trans. Brundage, pp. 259-62; *Itinerarium* 1.9, ed. Stubbs, pp. 20-21, trans. Nicholson, pp. 38-39; Ernoul, *Chronique* 18, ed. de Mas Latrie, pp. 211-14; *Eracles* 23.55-57, RHC Oc 2, pp. 83–85; Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 2:325.

[474] 'Imad al-Din, *al-Fath*, trans. Massé, pp. 45-46. Costello's translation of Gabrieli's translation is slightly different: "He [Saladin] mounted catapults, and by this means milked the udders of slaughter...The bases of the walls and the teeth of their battlements were battered and broken down by stones from the catapults' slings; they seem like madmen throwing stones at random, impregnable gallant knights, mountains crossed with ropes, living beings aided by others, mothers of disaster and death, pregnant with calamity. Their missiles were invincible, all precautions against them were useless. Their darts vibrated with menace, their flight nourished on the bile of perceptive men. How many boulders came down out of heaven upon them, how many blocks of sandstone plunged into the earth, how many blazing firebrands bespattered them! The

It is unclear whether counterweight- or traction-powered trebuchets are described: both types of engines require the hauling of ropes. The degree of destruction suggests the use counterweight trebuchets while the apparent rate of fire is indicative of traction trebuchets. There is illustrative evidence that counterweight technology was known by this time;[475] however, there is nothing exceptional in any of the Muslim or Frankish accounts to confirm their use in 1187.

Regardless of its power, Saladin employed his artillery as a supporting weapon. According to accounts from both sides, he used it to restrict the garrison's ability to maintain an active defence, allowing his miners to approach the city walls.[476] Although more distant than some of his contemporaries, Ibn al-Athir clearly explains how archers advanced with the sappers as they crossed the fosse while the artillery constantly bombarded the parapet, keeping it clear of defenders. This is very similar to the sentiments expressed in the *De expugnatione terrae sanctae*. It is unclear how far the sappers had progressed by the time that the city's defenders, fearing a breach, capitulated on 2 October.[477] With Jerusalem in hand, Saladin departed on 30 October for Acre and then onwards to Tyre on 8 November, the Franks' last foothold on the Palestinian coast and a vital link with Europe.

Tyre: 1187

The proverbial strength of Tyre's defences impressed onlookers around the end of the twelfth century as it had in antiquity.[478] Saladin arrived on 12 November 1187 but was

damage caused by the catapults, the extraordinary extent of their devastation, the effects of their concentration, the whistling wind of their flight, the extent of their range were beyond compare. The attack from their catapults never ceased, the battery of their mangonels, the drawing of water with their ropes, the parading in their halters, the attacking and defending, prostrating and slashing open, shaking their buckets, becoming downcast at their misfortunes, dissolving the composure of strong men with the boulders that they shot one after another, smashing the huddles of buildings, breaking them down into ruins, demolishing their foundations, breaking their joints by hauling them within their ropes, exhausting the wells by drinking from them with their own cups, until they reduced the walls to a single line of bricks and drove their defenders away. The enemy's ordnance was smashed and broken, the moat crossed and the attack sustained..." 'Imad al-Din, *al-Fath*, trans. in Gabrieli, *Arab Historians*, pp. 154-56.

[475] See **Fig. C1**.

[476] *De expugnatione terrae sanctae*, ed. Stevenson, pp. 244-46, trans. Brundage, pp. 160-62; *Eracles* 23.55-57, RHC Oc 2, pp. 83-85. Baha' al-Din, *al-Nawadir*, trans. Richards, p. 77; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:331.

[477] Benvenisti takes a literal interpretation and suggests that the sappers covered an incredible 30 m within two days, Benvenisti, *The Crusaders*, p. 44. Prawer places the mine at precisely the same point where the Franks broke into Jerusalem in 1099 and the Persians entered in 614, Prawer, "The Jerusalem the Crusaders Captured," p. 14.

[478] William of Tyre, *Chronicon* 22.30 (29), ed. Huygens, 2:1,057, trans. Babcock and Krey, 2:501; Ibn Jubayr, *Rihla*, trans. Broadhurst, p. 319-20; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:328; Wilbrand of Oldenburg 1.2, ed. Pringle, p. 117, trans. Pringle, p. 63. See also Ibn Battuta, *Tuhfat*, trans. Gibb, p. 58. For

forced to wait until 25 November for his son, al-Zahir Ghazi, and his artillery to arrive. Once his forces assembled, Saladin established his camp on a hill near the famous causeway and began to attack the city.[479] The Ernoul account states that Saladin employed seventeen *perrieres* and *mangonniaus*, while the *Eracles* counts fourteen *perrieres* and *mangoneaus* and a letter from Brother Terricus of the Templars to Henry II of England notes thirteen *perrariae*.[480] The Muslim accounts give no numbers; 'Imad al-Din states simply that there were both large and small stone-throwers and gives the impression that they were worked by teams in relay.[481]

Although the Frankish sources use two terms to describe Saladin's artillery, this on its own is not sufficient evidence to conclude that more than one type of engine was employed; however, such a suggestion appears more plausible when taking into consideration 'Imad al-Din's reference to large and small engines. It is still a jump to assert that these represent counterweight and traction engines; but whatever engines were used at Tyre were likely to have been the same that had been used at Jerusalem only weeks earlier. Little more about these engines can be discerned as the sources instead focus on Saladin's use of siege towers at Tyre and the naval engagement in late December that ultimately compelled the sultan to end the siege.

Saladin's treatment of his artillery is unclear following his decision to lift the siege. According to many Frankish sources, Saladin burnt his engines before departing;[482] however, Baha' al-Din states that Saladin disassembled his artillery and withdrew it with the army, only burning what could not be taken away.[483] If Saladin was making use of prefabricated engines, moving them from Ascalon to Jerusalem to Tyre, and especially if some of these were counterweight trebuchets, it would seem inexplicable why he would burn these as he was not threatened by another field army. If Saladin destroyed some of

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the medieval defences of Tyre, see Conder and Kitchener, *Survey of Western Palestine*, 1:72; Pringle, "Town Defences," 85-88; Pringle, *Churches*, 4:178-80.

[479] Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 78-79; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 63-65; *Eracles* 24.2, RHC Oc 2, pp. 104-5; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 342-44; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:335-38.

[480] Ernoul, *Chronique* 20, ed. de Mas Latrie, p. 237; *Eracles* 24.2, RHC Oc 2, p. 105; letter from Terricus of the Temple to Henry II of England, in Roger of Howden, *Chronica*, ed. Stubbs, 2:346-47, trans. Riley, 2:90-91.

[481] 'Imad al-Din, *al-Fath*, trans. Massé, pp. 64-65.

[482] *Eracles* 24.4, RHC Oc 2, p. 110; *Itinerarium* 1.10, ed. Stubbs, p. 25, trans. Nicholson, p. 41; William of Newburgh, *Historia rerum Anglicarum* 3.20, ed. Howlett, 1:264-65; Marino Sanudo, *Liber secretorum* 3.9.8, ed. Bongars, pp. 193-94, trans. Lock, pp. 307-8. Cf. Ernoul, *Chronique* 21, ed. de Mas Latrie, p. 224.

[483] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 79. Cf. 'Imad al-Din, *al-Fath*, trans. Massé, pp. 79-80.

his artillery, it would most likely have been his smaller engines, perhaps those which had been built on site or those not worth the trouble of storing over the winter.

Saladin spent a considerable portion of the winter of 1188, as well that of 1189, in Acre, while most of his army was sent home for the season. Baha' al-Din Qaraqush al-Asadi, who had constructed Saladin's citadel in Cairo, was summoned from Egypt to strengthen Acre. References to him bringing labourers and supplies with him from Egypt support the possibility that Saladin may have similarly brought artillery out of Egypt, to use in greater Syria, at some point over the preceding decade.[484] Saladin had acquired most of Palestine by the end of 1187 but the strongholds of eastern Galilee, Transjordan, and most of Lebanon and the lands farther north remained in Frankish hands.[485]

Eastern Galilee: 1188

In the second half of 1187, while Saladin was campaigning primarily against major urban centres, smaller contingents of his army were sent to oppose the castles of Belvoir, Safed, and Chateau Neuf (Hunin), which overlook the upper Jordan valley. Chateau Neuf surrendered in December 1187,[486] but the relatively new Hospitaller stronghold of Belvoir and the hilltop castle of Safed, a Templar possession since 1167, which had been blockaded by August, defiantly held out. In December 1187 or January 1188, the garrison of Belvoir launched a successful sally, capturing provisions and arms.[487] This led Saladin to move what forces he had retained over the winter against the castle in March 1188.[488] Despite the suitable topography around the castle, neither Saladin nor the earlier

[484] 'Imad al-Din, *al-Fath*, trans. Massé, pp. 108-9; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 393; Baha' al-Din, *al-Nawadir*, trans. Richards, p. 90; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 87. 'Imad al-Din and Baha' al-Din, as well as al-Maqrizi, note that this figure was left to complete the defences of Acre, and possibly the wider area, when Saladin left Acre following his time there over the winter of 1189. When considering 'Imad al-Din's account, it is possible that he may have held this position since the winter of 1188.

[485] For the contemporary significance of these strongholds, see letter from the East to the Master of the Hospitallers of Italy, 1187, in Ansbert, *Historia*, FRA (1 Abt.) 5, p. 3, MGH SRG 5, pp. 3-4, trans. Loud, p. 35; letter of the Master of the Temple to Henry II of England, in Roger of Howden, *Chronica*, ed. Stubbs, 2:346-47, trans. Riley, 2:90-91.

[486] 'Imad al-Din, *al-Fath*, trans. Massé, pp. 75-76; Baha' al-Din, *al-Nawadir*, trans. Richards, p. 79; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:338; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 345. For discussions of Chateau Neuf, see Conder and Kitchener, *Survey of Western Palestine*, 1:123-24; Deschamps, *Les Chateaux des Croisés*, 2:130-31, pl. XXXIV A-C; Pringle, *Secular Buildings*, no. 164, pp. 79-80; Boas, *Crusader Archaeology*, p. 103. See also Ibn Jubayr, *Rihla*, trans. Broadhurst, p. 315.

[487] Roger of Howden, *Chronica*, ed. Stubbs, 2:346-47, trans. Riley, 2:90; Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 79-80; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 81-82; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 344-45; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:339.

[488] Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 79-80; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 103-4; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 346-47; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:344.

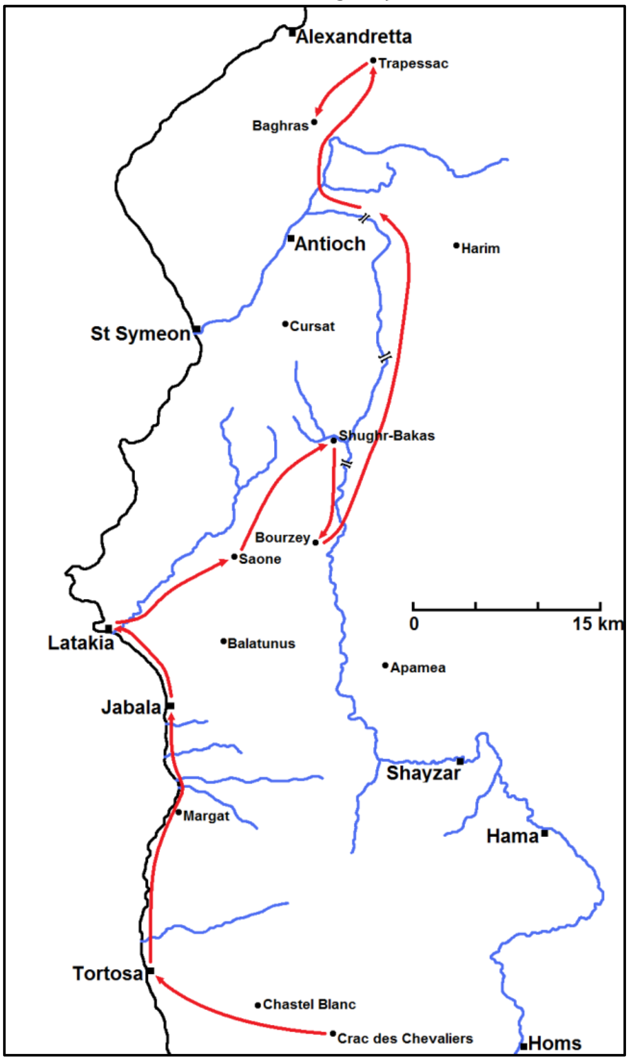
blockading force appear to have employed artillery. Instead, Saladin sent his small force in waves against the castle, much as he had at Beirut in 1182. This proved ineffective. A force was left to continue the blockade while Saladin departed for Damascus, where he arrived on 5 May 1188. For the time being, Belvoir and Safed remained Frankish outposts in Eastern Galilee.

Indications of Range in Western Syria and Transjordan

Saladin left Damascus soon after arriving and mustered his army to the east of Crac des Chevaliers (Hisn al-Akrad). He sent al-Zahir Ghazi and Taqi al-Din to oppose Antioch while contingents of the army raided as far as Tripoli before the main body set out towards Tortosa on 1 July 1188.

Saladin does not appear to have employed artillery during the early part of his campaign as he travelled up the Syrian coast from Tortosa to Latakia.[489] Frontal assaults were sufficient to take the town defences of Tortosa and one of its two tower-keeps, but neither offensive nor defensive artillery appear to have factored into the failed attempt to take the Templars' tower, although neither did mining.[490] Maraclea was occupied

Saladin's movement through Syria, 1188



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[489] For the inclusion of various smaller components that broke off and rejoined the main force, see Deschamps, *Les Chateaux des Croisés,* 3:127-31.

[490] Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 82-83; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 124-25; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:345; Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 59; letter of

Origin	Destination	Siege
Crac (1 July)	Tortosa (3 July)	Tortosa: 3 July - 11 July
Tortosa (11 July)	Jabala (15 July)	Jabala: 15 July - 16 July
Jabala (20 July)	Latakia (21 July)	Latakia: 21 July - 22 July
Latakia (24 July)	Saone (26 July)	Saone: 27 July - 29 July
Saone (30 July)	Shughr-Bakas (2 Aug)	Shughr-Bakas: 2 Aug? - 12 Aug
Shughr-Bakas (>13 Aug)	Bourzey (20 Aug)	Bourzey: 21 Aug - 23 Aug
Bourzey (>23 Aug)	Iron Bridge (?)	*Pause at the Iron Bridge*
Iron Bridge (?)	Trapessac (2 Sep)	Trapessac: 2 Sep - 16 Sep
Trepessac (17 Sep)	Baghras (17 Sep)	Baghras: 17 Sep - 26 Sep

unopposed and the town of Jabala (Gibellum) was surrendered before Saladin had finished arranging his forces against it. The castle followed suit the following day after a single attack.[491] 'Imad al-Din appears to be the only source to mention stones being thrown, but does not specify if this was done with machines. At Latakia, the miners who were responsible for the capture of the city seem not to have been supported by artillery.[492] From a Frankish perspective, the *Itinerarium* also portrays Saladin's push up the coast as a series of attacks rather than sieges.[493] Although artillery is not mentioned as part of the more complex operations at Tortosa or Latakia, it suddenly becomes a critical element as the army turned inland.

<u>Saone: 1188</u>

Saone was the first stronghold that Saladin's army encountered after turning away from the coast. The castle was one of a number of Byzantine outposts in the Syrian hills that had been developed by the Franks.[494] That castle sits on a spur with wadis over 200 m wide to the north and south. The original Byzantine citadel was surrounded by a central enceinte and an additional bailey was built on either side of this. Dividing the castle from the remainder of the spur was one of the most impressive medieval fosses, almost 40 m

Hermenger to Leopold V of Austria, in Ansbert, *Historia*, FRA (1 Abt.) 5, p. 4, MGH SRG 5, pp. 4-5, trans. Loud, pp. 35-36.

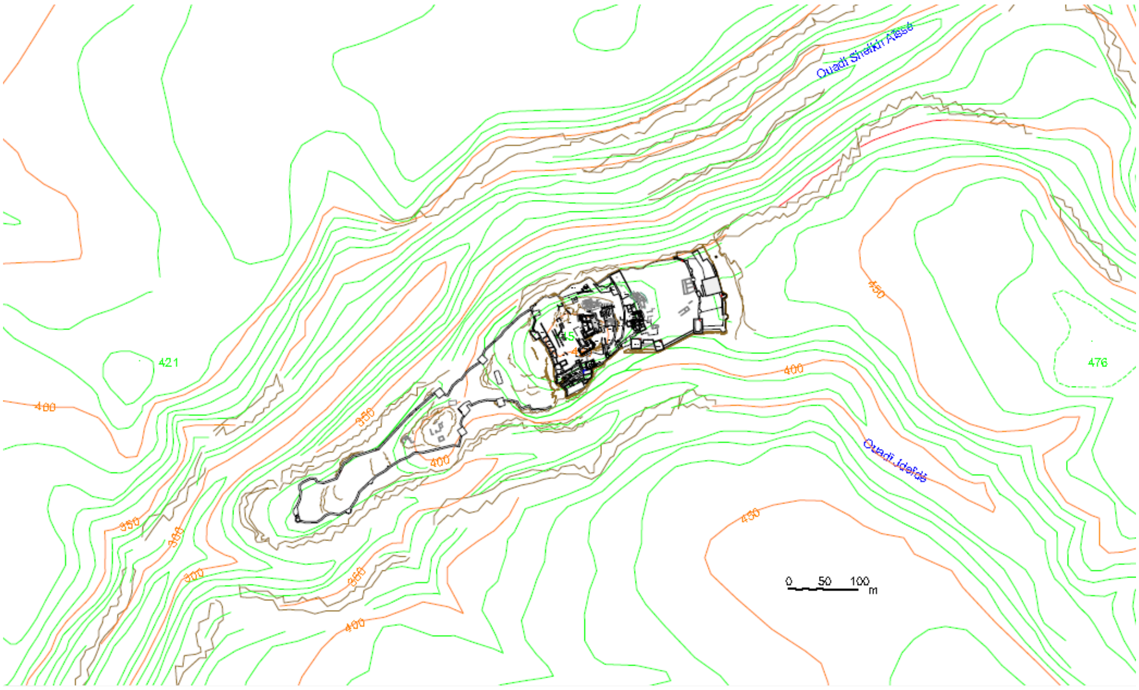
[491] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 82; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 125-28; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:345; Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 59; Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 59.

[492] Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 82-83; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 128-31; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:346-47; Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 59.

[493] *Itinerarium* 1.13, ed. Stubbs, pp. 26-27, trans. Nicholson, p. 43.

[494] Matthew of Edessa, *Patmowt'iwn*, trans. Dostourian, p. 32; Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2: 708-9; A. W. Lawrence, "A Skeletal History," p. 218. See also Michaudel,"Étude historique," p. 6; Saadé, "Histoire du Château de Saladin," pp. 985-87; Deschamps, *Les Chateaux des Croisés*, 3:219-20. For the Frankish lordship of Saone, see Michaudel,"Étude historique," pp. 6-9; Saadé, "Histoire du Château de Saladin," pp. 987-91; Deschamps, *Les Chateaux des Croisés*, 3:227-28. Bourzey and Balatunus were among the other Byzantine strongpoints developed by the Franks in this region.

Saone: castle, plan and topography (from Mesqui)



deep and approaching 20 m wide.[495] The outer eastern wall is pierced by thirty-two embrasures along the ground floor level alone, indicating that its designers regarded a massed assault to be more threatening than any artillery, as these apertures would have detracted from the wall's strength.

The Muslim army arrived at Saone on 26 July. Baha' al-Din states that Saladin erected six stone-throwers early the following day, and although he does not give Saladin's position, 'Imad al-Din indicates that he was positioned on the spur facing the castle's eastern fosse. This would have been an ideal position in which to erect artillery. The sources unanimously place al-Zahir Ghazi elsewhere in a secondary position with another one or two trebuchets, ambiguously claiming that he was along the side of one of the wadis facing a certain promontory of the castle. The sources claim that al-Zahir Ghazi and his Aleppan forces were able to damage a section of wall with their artillery and some appear to suggest that it was here that Muslim forces broke in during the successful attack that was launched on 29 July.[496]

[495] Baha' al-Din states that the fosse is 60 cubits deep (32.4 m according to the standard Egyptian measure). For studies and descriptions of Saone, see Mesqui, "Saône"; Michaudel, "Le château de Saône"; Saadé, "Histoire du Château de Saladin," pp. 980-1,016; Kennedy, *Crusader Castles*, pp. 84-95; Boase, "Military Architecture," pp. 145-49; Müller-Wiener, *Castles of the Crusaders*, pp. 44-45; Deschamps, *Les Chateaux des Croisés*, 3:217-47; T. E. Lawrence, *Crusader Castles*, ed. Pringle, pp. 42-49; Rey, *Étude sur les monuments*, pp. 105-13.

[496] Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 84-85; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 131-32; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 365-67; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:347-48.

Interpreting the events of this siege, Gabriel Saadé argued that that al-Zahir Ghazi's artillery was able to breach the north wall of the western bailey from across the northern wadi.[497] An alternative theory has been put forward by Benjamin Michaudel and Jean Mesqui, who suggest that the breach mentioned in the sources was created by Saladin's artillery at the north end of the eastern wall.[498] Both theories, however, rely on misinterpretations of the power of contemporary artillery.

Saadé's theory holds that contemporary artillery not only had a range of over 200 m but that it could throw stones large enough to inflict significant damage from this distance. While there is some circumstantial evidence that small stones might have been thrown this far, it would appear impossible that one or two engines operating at such a distance could have opened a breach in less than forty-eight hours. Although counterweight trebuchets were extremely accurate, the prolonged flight time would magnify the variables which compromise precision.[499] Furthermore, the high angle of release necessary to throw a projectile this distance would compromise the amount of energy transferred on impact, because of the reciprocally steep angle of impact. It is doubtful whether swing-beam engines could ever have achieved such a task.

If the supposed artillery damage was instead inflicted at the north end of the eastern wall, the issue is one of power alone. When placed in the broader context, there is no evidence that artillery powerful enough to breach defensive masonry over 2 m thick in only two days was ever employed during the twelfth century. Consider the prolonged periods of bombardment that the northern defences of Kerak were subjected to during 1183 and 1184. If engines powerful enough to inflict the degree of damage that has been suggested existed, it is inexplicable why they were not employed with equal devastation at most other sieges. On this occasion, it seems the generally reliable Baha' al-Din borrowed heavily from the more exuberant 'Imad al-Din. He may have been inclined to incorporate the exaggeration of al-Zahir Ghazi's engines as he was under the patronage of al-Zahir when composing his account.[500] Artillery probably played a much less significant role at this siege than has previously been thought, used to support the assault

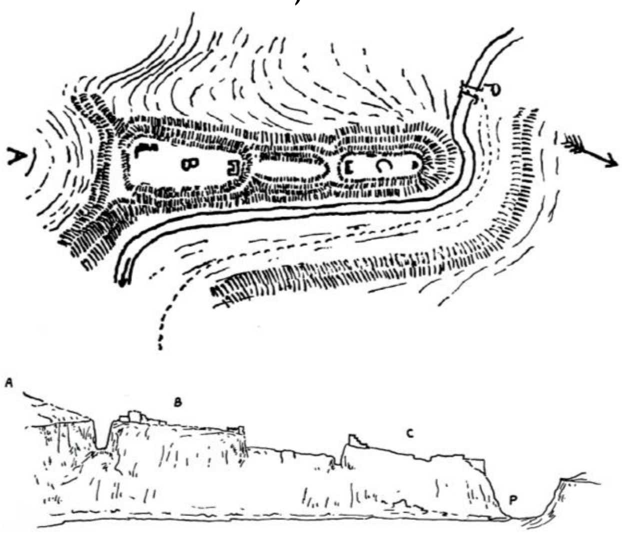
[497] Saadé, "Histoire du Château de Saladin," pp. 997-1,002.
[498] Michaudel, "Étude historique," pp. 15-16; Mesqui, "Saône," p. 14. See also Michaudel, "Le château de Saône," p. 3.
[499] These variables include pre-release factors that influence a projectile's release trajectory as well as environmental elements that affect the projectile while in flight.
[500] For these authors and the relation between their texts, see Richards, "A Consideration of Two Sources," pp. 46-65.

troops that ultimately stormed the castle rather than creating a breach through which they could enter.[501]

Shughr-Bakas: 1188

Saladin took the main contingent of his army away from Saone on 30 July 1188 and on 2 August he encamped it on the banks of the Orontes near the stronghold of Shughr-Bakas. This castle, in the heights above the important Jisr ash-Shughr, had two distinct wards, divided by a fosse that cut across the spur.[502] According to Baha' al-Din and 'Imad al-Din, Saladin took a detachment and assaulted Bakas until it was taken on 5 August. According to the former, it was acquired by force, whereas the latter claims that that the garrison surrendered.[503] Ibn al-Athir states that the Franks abandoned this portion of the castle when the Muslims arrived.[504] Only Baha' al-Din mentions the use of artillery against the Bakas portion of the castle, but all three agree that it was used against ash-Shughr.

Shughr-Bakas: castle, plan and elevation (from Van Berchem and Fatio)



Baha' al-Din claims that ash-Shughr was bombarded from all sides, leaving the defenders no choice but to surrender. Although he does not explicitly state that Saladin's artillery was able to reach the castle, this would appear to be implied. 'Imad al-Din states that neither artillery nor archers could reach the castle; but despairing of taking it in a frontal assault, Saladin nevertheless resorted to setting up these engines. Ibn al-Athir appears to give the clearest description of events, stating that some shots were able to reach the castle but that they had no effect. When read together, the three accounts appear to agree that although a few shots were able to reach ash-Shughr, these were likely very light projectiles that made little impact. According to the

[501] For a more thorough investigation of this siege and how artillery may have been employed, see Fulton, "A Ridge too Far."
[502] For Shughr-Bakas, see Deschamps, *Les Chateaux des Croisés*, 3:349-50; Boase, "Military Architecture," p. 162.
[503] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 85; 'Imad al-Din, *al-Fath*, trans. Massé, p. 133.
[504] Ibn al-Athir, *al-Kamil*, trans. Richards, 2:348.

latter two accounts, the situation was so hopeless that the Muslim forces were shocked when the garrison asked for terms on 9 August.[505]

If Van Berchem and Deschamps are correct in identifying the southern component of the castle as Bakas and the northern part as ash-Shughr, which seems sensible, the former sits at a greater elevation than the latter.[506] This means that Saladin either besieged ash-Shughr from a direction other than Bakas, or that his engines were incapable of a range greater than the width of the fosse between them. If Saladin positioned his artillery in the valleys below the castle, this would clearly support Baha' al-Din's statement that the castle was assailed from all sides as well as 'Imad al-Din and Ibn al-Athir's claims that the artillery struggled to reach the castle's lofty walls. However, it is hard to imagine why Saladin would not have taken advantage of the higher elevation once he had taken Bakas. Had he been able to move his trebuchets to the plateau east of Saone, it would appear sensible for him to now move them up to Bakas, from which he could assail ash-Shughr. Regardless, having occupied both parts of the castle, Saladin moved his army south to Bourzey.

Bourzey: 1188

Sitting on a conical peak, 320 m above the floor of the Orontes valley to the east, Bourzey had been a notable Byzantine outpost.[507] When Saladin arrived on 20 August, he again encamped the bulk of his army on the banks of the Orontes. The next day, after surveying the site, he moved a secondary assault force and his artillery up to the col between the castle and hills rising to the west.[508]

The plateau below the castle is about 425 m above sea level, beginning about 30 m horizontally from the plane of the castle's western wall and extending about 60 m to the west and 100 m to the southwest. Above this position, the foundations of the south end of the castle's western face are about 460 m above sea level and the Byzantine citadel,

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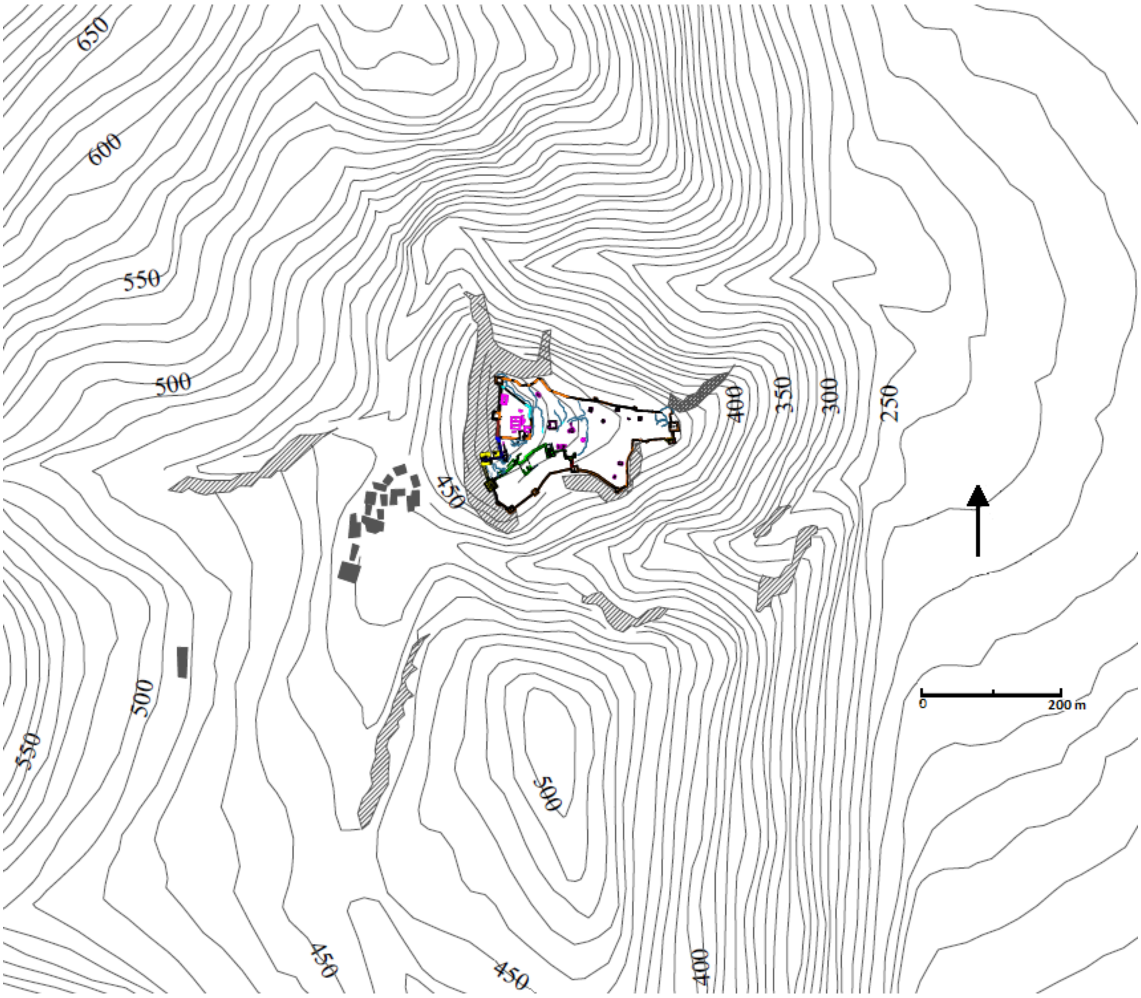
505 Baha' al-Din, *al-Nawadir*, trans. Richards, p. 85; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 134-35; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:348-49. See also Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 59.

506 Deschamps, *Les Chateaux des Croisés*, 3:349-50; Van Berchem and Fatio, *Voyages en Syrie*, 1:251-53.

507 For the early history of Bourzey, see Mesqui and Michaudel, "Bourzey," pp. 4-6; Mesqui, "Bourzey," p. 97; Michaudel, "Étude historique," pp. 4-5; Deschamps, *Les Chateaux des Croisés*, 3:345-46. See also Anna Comnena, *Alexiad* 13.12, trans. Dawes, p. 354. For the castle, see Mesqui and Michaudel, "Bourzey"; Mesqui, "Bourzey"; Kennedy, *Crusader Castles*, pp. 81-83; Boase, "Military Architecture," p. 162; Deschamps, *Les Chateaux des Croisés*, 3:346-48.

508 Baha' al-Din, *al-Nawadir*, trans. Richards, p. 86; 'Imad al-Din, *al-Fath*, trans. Massé, p. 136; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:349-50; Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 59.

Bourzey: castle, plan and topography (from Mesqui)



in the northwest corner of the castle, caps the highest point of the hill, about 500 m above sea level.[509]

Baha' al-Din states that men surrounded the castle and that artillery was fired at it day and night. As at ash-Shughr, he again implies that the besieging artillery had no trouble reaching the castle; but suspiciously, there is no description of any damage. This conflicts with 'Imad al-Din's account, which states that the besieging artillery was insufficiently powerful to assail the castle, as at ash-Shughr, forcing Saladin to resort to frontal assaults two days later. Ibn al-Athir states that there was a position from which artillery could reach the castle but that a defensive engine within was able to put the Muslim trebuchets out of action on 22 August, events which he claims to have witnessed from a hill overlooking the castle.[510]

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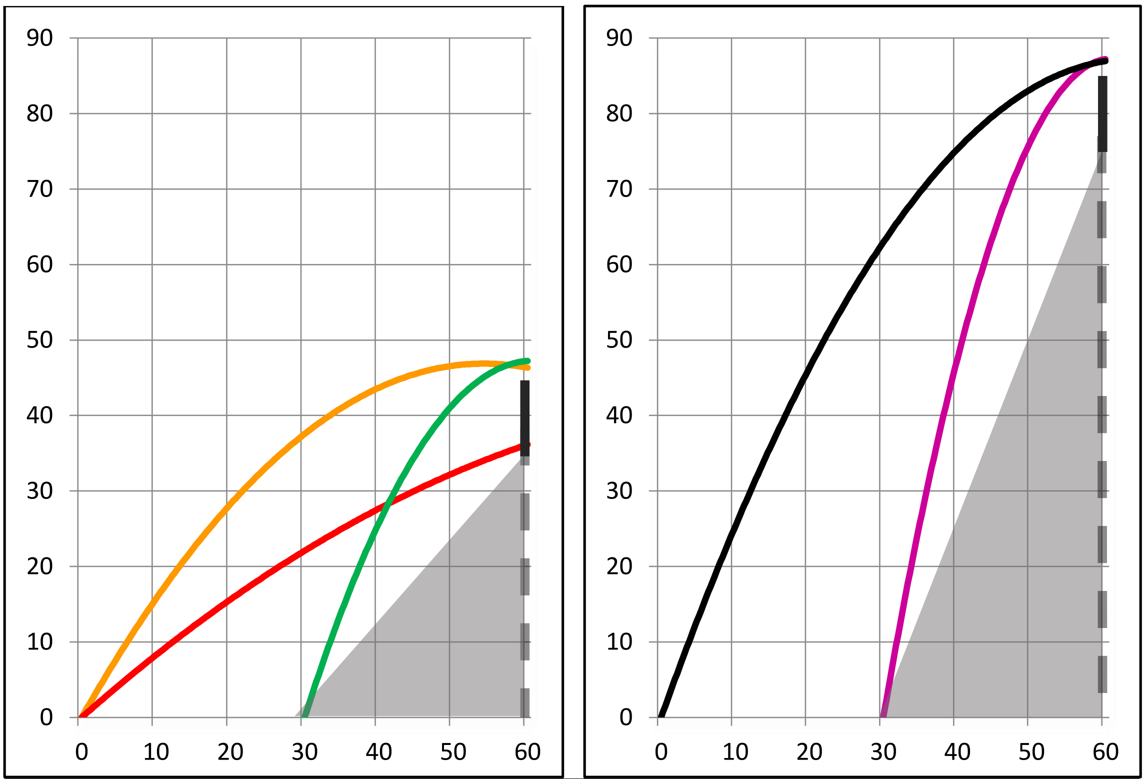
[509] The Franco-Syrian expedition concluded that the elevation disparity between the point at which they suspected that Saladin planted his engines and the foundations of the walls which they assailed was about 60 m, Mesqui and Michaudel, "Bourzey," p. 11.

[510] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 86; 'Imad al-Din, *al-Fath*, trans. Massé, p. 136; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:350. See also Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 59.

Given the distances and elevations involved, it would appear possible for artillery to reach the southern sections of Bourzey's western face; however, the citadel would have been harder to assail. A minimum release velocity of 32 m/s is necessary to reach the lowest battlements of the western face (at an estimated elevation of 45 m). With a release velocity of 35 m/s, for which a precedent appears to have been established earlier at Harim,[511] an engine could be placed in the centre of the plateau and assail this lowest parapet with a release angle of 60°, increasing horizontal velocity by 77%. To reach the battlements of the Byzantine citadel, a release velocity of 42 m/s is necessary from the edge of the plateau or 44 m/s from 30 m farther back. Had Saladin's engines been capable of this, so too could they have fired projectiles of the same mass against the base of the lowest portion of wall with a horizontal velocity of 33 m/s.



Release Angle	72°	60°	41°	80°	70°
Velocity	32 m/s	35 m/s	44 m/s	42 m/s	44 m/s
Horizontal Velocity	9.9 m/s	17.5 m/s	33.2 m/s	7.3 m/s	15.0 m/s
Max. Horizontal Range	61.42 m	108.25 m	195.63 m	61.56 m	126.98 m
Max. Vertical Range	47.26 m	46.87 m	42.51 m	87.29 m	87.22 m
Vertical Range at 60 m	47.23 m	46.32 m	36.16 m	59.82 m	86.96 m

[511] See Chapter 4.

The absence of archaeological evidence of the mass of the projectiles prevents an accurate calculation of the energy, and thus destruction, that Saladin's engines might have been able to produce. If Saladin's artillery struggled to reach the walls of Bourzey, it is almost certain that these were traction trebuchets throwing quite small projectiles; however, if the engines were not only able to reach the castle but inflict damage, which is not mentioned by any of the sources, these would necessarily have been counterweight trebuchets.

The lack of agreement between Baha' al-Din, 'Imad al-Din and Ibn al-Athir makes it impossible to say with certainty whether Saladin was using traction- or small counterweight-powered engines. But given the absence of any suggestions of damage, these would appear to have been relatively light engines throwing small projectiles against the garrison, rather than the bulk of the walls. This would appear to support Ibn al-Athir's observations at ash-Shughr: although the castle was theoretically within range, its elevation placed it beyond effective range. What Baha' al-Din, 'Imad al-Din and Ibn al-Athir do agree on is that it was acknowledged that Bourzey would not fall due to artillery damage. This contrasts the apparent artillery damage inflicted at Saone but reflects the same tactical approach of setting up artillery followed by a general assault a few days later.[512]

On 23 August, Saladin divided his army into three divisions to attack the castle of Bourzey in rotation.[513] Around mid-day, after the Franks had repulsed the first wave with arrows and stones, the second wave, supported by elements of the third and first, scaled the western wall. While the Franks were forced back to the citadel, contingents from the main army had made their way up the steep eastern slope and managed to scale the outer eastern walls, devoid of defenders.[514] From the citadel, the garrison surrendered themselves into captivity, allowing Saladin to move north to the Iron Bridge and the environs of Antioch.[515]

[512] See Fulton, "A Ridge Too Far."
[513] For the use of such attacks in rotation, see the sieges of Montferrand (1137) and Beirut (1182) in Chapter 4 and Belvoir (1188) above.
[514] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 86; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 136-39; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:350-51. Cf. the account of Ibn Wasil, trans. in Mesqui and Michaudel, "Bourzey," p. 8. Ibn al-Athir describes the gradient beyond the outer eastern bailey as climbable but too steep to fight from.
[515] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 86; 'Imad al-Din, *al-Fath*, trans. Massé, p. 139; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:351-52.

The Syrian Gates: 1188

Saladin appears to have used artillery against both Trapessac (Darbasak) and Baghras (Gaston), the Templar castles that secured the Syrian Gates north of Antioch, in September 1188.[516] In a reversal, 'Imad al-Din, rather than Baha' al-Din, is the most generous with his praise of the artillery at these sieges. During the former, Ibn al-Athir claims that the engines were able to inflict no damage while at the latter they were rendered ineffective by the relative elevation of Baghras. These observations are somewhat puzzling because Trapessac occupies a rise similar to the tell at Harim and Baghras is relatively approachable on two fronts. Although the elevation of Trapessac may have provided the castle with protection, Baghras, tucked up further into the mountains, could have been assailed from the south, avoiding the sheer cliffs to the west and north and steeper grade to the east.[517] Baha' al-Din's account is exceptionally brief as he was not present during these events.[518] While mining efforts forced the garrison of Trapessac to seek terms, it would appear the Templar garrison of Baghras sought favourable terms relatively quickly. Saladin then arranged a brief truce with Bohemond III and set off for Damascus via Aleppo.[519]

The Syrian campaign of 1188 is an important window into Saladin's siege practices. None of the sieges were particularly grand and the accounts are far from the most detailed; however, having two, and possibly even three, eyewitness accounts of these events makes them extremely important.[520] The regularity with which Saladin employed his artillery confirms its apparent importance, despite the conflicting reports of its power. The speed with which the army appears to have moved confirms the likelihood that these were prefabricated trebuchets, light enough to be set up overnight in most instances and easy enough to be moved through the hills of western Syria without too much difficulty.[521]

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[516] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 87; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 141-43; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:352-53.

[517] For the castle of Baghras, see A. W. Lawrence, "The Castle of Baghras," pp. 35-83.

[518] He accompanied one of the contingents that was dispatched to screen the main army from any attacks by the Franks by taking up a position in the plane north of Antioch.

[519] Baha' al-Din, *al-Nawadir*, trans. Richards. p. 87; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 144-45; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:353-54.

[520] Saadé has expressed this contentious belief, but Ibn al-Athir's contribution of information not found in either Baha' al-Din or 'Imad al-Din, such as the lady operating the defensive engine at Bourzey, and his use of the first person on occasion, make this a possibility. See Saadé, "Histoire du Château de Saladin," p. 996.

[521] For the broader development and use of prefabricated artillery, see Fulton, "Development of Prefabricated Artillery," pp. 51-72.

The Absence of Artillery in Transjordan

When the garrisons of Kerak and Montreal refused to surrender to free their lord, Humphrey IV of Toron,[522] the task of reducing the strongholds was given to al-'Adil. Both castles were under strict blockades, led by Sa'ad al-Din Kamshaba, by the autumn of 1187.[523] Neither direct assaults nor artillery appear to have been used against Kerak in 1188, despite Saladin's use of such engines here in 1183 and 1184. Although a portion of the garrison had left to fight at Hattin, the defenders were still in a strong enough position to secure their liberty, and that of their lord, when supplies ran out and they were forced to surrender sometime between 24 October and 23 November 1188.[524] To the south, the older, further isolated and less celebrated castle of Montreal continued to hold out. It was not until April or May 1189 that the castle's garrison surrendered the stronghold, having endured more than a year of uninterrupted but passive blockade.[525] So far from Frankish support, the determined resistance offered by the garrison is bewildering.

In his assessment of the extended blockade of Montreal, Hugh Kennedy has proposed that the castle's ability to endure was due to its topographic isolation, which prevented the Muslims from bringing siege engines up to its walls.[526] Although the castle's topographic position was the key to its strength, Muslim forces rarely used rams and siege towers in the Near East; mining, often supported by artillery, and frontal attacks were much more common tactics. The position from which artillery could assail Montreal is a plateau to the northwest of the castle, now occupied by the visitors' centre. Similar to the ridge south of Kerak, the castle is less than 150 m away but at a slightly higher elevation, requiring projectiles be thrown with a release velocity of about 40 m/s. This would necessitate a counterweight trebuchet to batter the battlements or inflict any degree of damage. Notably, William of Tyre describes Montreal as being beyond the range of machines and bows,[527] although it must be admitted that he probably never visited the castle. It is perhaps indicative that it was not until the end of the thirteenth century that

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[522] 'Imad al-Din, *al-Fath*, trans. Massé, pp. 104-7; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:333.

[523] 'Imad al-Din, *al-Fath*, trans. Massé, p. 107. Kerak may have been continuously opposed by a small force since Saladin left the castle in June 1187.

[524] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 88; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 381-82; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 87-88; *Eracles* 26.9, RHC Oc 2, p. 188. The smaller strongholds of the region also appear to have fallen around this point, Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 382; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:354-55. See also Vannini and Tonghini, "Medieval Petra," 371-84.

[525] *Itinerarium* 1.15, ed. Stubbs, pp. 29-30, trans. Nicholson, pp. 45-46. See also, Baha' al-Din, *al-Nawadir*, trans. Richards, p. 91; *Eracles* 24.2, 26.9, RHC Oc 2, pp. 104-5 (lower text), 188.

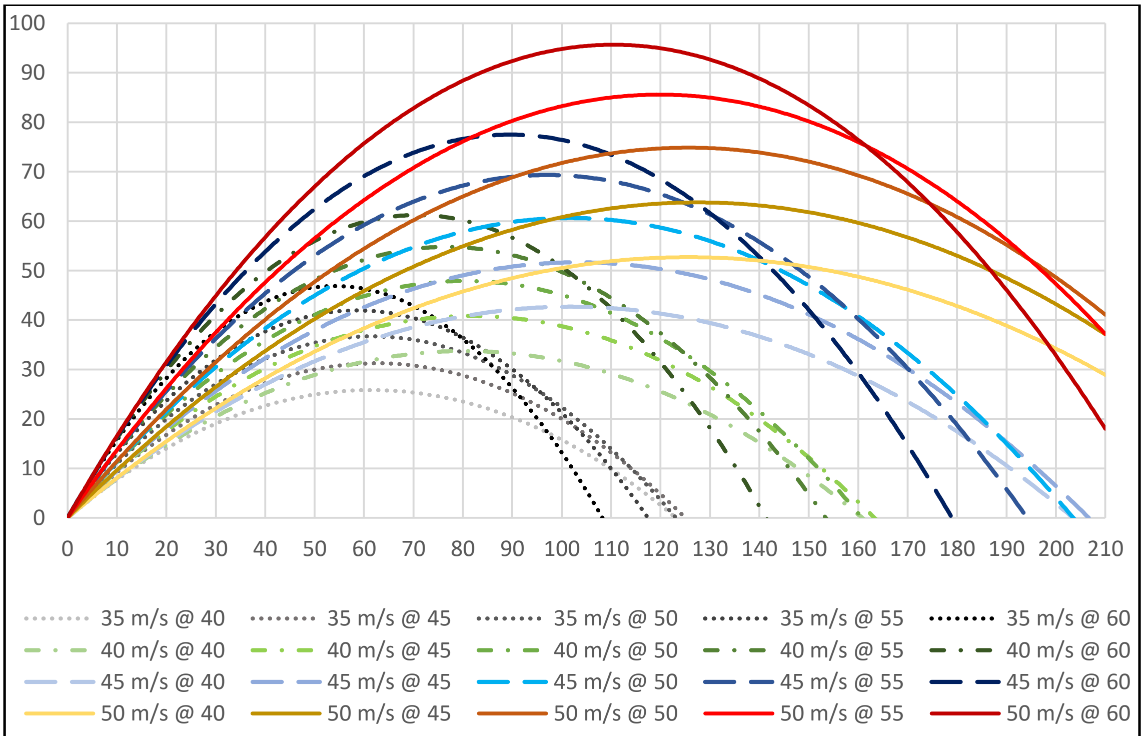
[526] Kennedy, *Crusader Castles*, p. 111.

[527] William of Tyre, *Chronicon* 20.27, ed. Huygens, 2:951, trans. Babcock and Krey, 2:389.

the northwest front of Montreal and southern defences of Kerak were significantly refortified, by which point artillery had become significantly more powerful.[528]

The Significance of Range

As was touched upon when dealing with the siege of Harim in 1177, trebuchets capable of releasing projectiles at a velocity around 40 m/s or a range greater than about 150 m, were likely counterweight engines. Even with a sense of range, the power of a counterweight trebuchet cannot be determined unless the mass of its projectiles is known.



V	α	Vh	Rh max	Rv max	Rv at 50 m	Rv at 100 m	Rv at 150 m	Rv at 200m
35 m/s	40°	26.8 m/s	123.1 m	25.8 m	24.9 m	15.8 m	-27.5 m	-104.8 m
	45°	24.8 m/s	125.0 m	31.2 m	30.0 m	19.2 m	-30.0 m	-120.0 m
	50°	22.5 m/s	123.1 m	36.7 m	35.4 m	22.4 m	-39.1 m	-148.9 m
	55°	20.1 m/s	117.5 m	41.9 m	41.0 m	21.2 m	-59.3 m	-200.7 m
	60°	17.5 m/s	180.2 m	46.9 m	46.9 m	13.2 m	-100.2 m	-293.6 m
40 m/s	40°	30.6 m/s	160.8 m	33.7 m	28.9 m	31.7 m	-8.4 m	-40.9 m
	45°	28.3 m/s	163.3 m	40.8 m	34.7 m	38.8 m	12.2 m	-45.0 m
	50°	25.7 m/s	160.8 m	47.9 m	41.1 m	45.0 m	11.0 m	-58.1 m
	55°	22.9 m/s	153.4 m	54.8 m	48.1 m	49.7 m	-4.8 m	-86.7 m
	60°	20.0 m/s	141.4 m	61.2 m	55.0 m	50.7 m	-15.8 m	-143.6 m

[528] For the development of the northwestern defences of Montreal, see Faucherre, et al., "La forteresse de Shawbak," pp. 62-64. For the development of the southern defence of Kerak, see Deschamps, *Les Chateaux des Croisés*, 2:88-89. For the relation of these building efforts to artillery, see Chapter 8.

45 m/s	40°	34.5 m/s	203.5 m	42.7 m	31.6 m	42.7 m	33.1 m	2.9 m
	45°	31.8 m/s	206.6 m	51.7 m	37.9 m	51.6 m	41.1 m	6.4 m
	50°	28.9 m/s	203.5 m	60.6 m	45.0 m	60.6 m	47.0 m	4.1 m
	55°	25.8 m/s	194.2 m	69.3 m	53.0 m	69.3 m	48.7 m	-8.6 m
	60°	22.5 m/s	179.0 m	77.5 m	62.4 m	76.4 m	42.0 m	-40.8 m
50 m/s	40°	38.3 m/s	251.2 m	52.7 m	33.6 m	50.5 m	50.7 m	34.2 m
	45°	35.4 m/s	255.1 m	63.8 m	40.2 m	60.8 m	61.8 m	43.2 m
	50°	32.1 m/s	251.2 m	74.8 m	47.7 m	71.7 m	72.0 m	48.6 m
	55°	28.7 m/s	239.7 m	85.6 m	56.5 m	83.2 m	80.2 m	47.3 m
	60°	25.0 m/s	220.9 m	95.7 m	67.0 m	94.8 m	83.4 m	32.8 m

In order to provide a general appreciation of scale, the power of certain engines can be modelled and used as a comparative. Applying a simplified formula, based on the initial and release angles of a beam, the dimensions of the beam and the sling, and an arbitrary factor of efficiency to represent the retarding forces of friction, a very rough estimate of release velocity can be rendered:

$$V = \left(\frac{\mathrm{Lla} + \mathrm{Ls}}{\mathrm{Lsa}}\right)\sqrt{2 \cdot g\left(2\left[\mathrm{Lsa} \cdot \sin\left(\frac{1}{2}\left[\frac{\pi(\theta - \alpha)}{180}\right]\right)\right]\right)}\,\mathrm{Eff}$$

As this does not take into account most dynamics of the mechanical system or even the masses involved, this is not a particularly accurate mathematical representation of a trebuchet's firing sequence but it is suitable to provide a general idea of the capabilities of engines of varying sizes. If *Arrangements A*, *B* and *D* are used and each is loaded so that the short arm is 135° to the vertical below (θ), the following values are produced:

Arrangement A (12 m beam, 5:1)

α	V at 100% Eff	V at 70% Eff	R at 70% Eff
40°	76.03 m/s	53.22 m/s	284.62 m
45°	74.46 m/s	52.12 m/s	277.19 m
50°	72.78 m/s	50.94 m/s	260.81 m
55°	70.99 m/s	49.69 m/s	236.78 m
60°	69.08 m/s	48.36 m/s	206.66 m

Arrangement B (6 m beam, 4:1)

α	V at 100% Eff	V at 70% Eff	R at 70% Eff
40°	43.01 m/s	30.11 m/s	91.08 m
45°	42.12 m/s	29.48 m/s	88.70 m
50°	41.17 m/a	28.82 m/s	83.46 m
55°	40.16 m/s	28.11 m/s	75.77 m
60°	39.08 m/s	27.36 m/s	66.13 m

Arrangement D (10 m beam, 4:1)

α	V at 100% Eff	V at 70% Eff	R at 70% Eff
40°	53.22 m/s	37.25 m/s	139.46 m
45°	52.12 m/s	36.48 m/s	135.82 m
50°	50.94 m/s	35.66 m/s	127.80 m
55°	49.69 m/s	34.78 m/s	116.02 m
60°	48.36 m/s	33.85 m/s	101.27 m

Although imperfect, these rough figures reveal the mechanical scale required to produce certain release velocities.[529] Although maximising range would appear to have been important to the Muslims in 1188, this should not be taken as a given in every scenario. Whereas reducing the mass of an engine's projectiles will generally increase release velocity and maximise range, heavier projectiles will maximise efficiency, ensuring as much potential energy as possible is transferred to the projectile. This will become an important consideration as artillery develops increasingly into a breaching weapon.

Saladin's Conquest of Northern Palestine

Safed: 1188

Around the start of November 1188 Saladin erected artillery against Safed.[530] Amidst heavy rains, Baha' al-Din states that Saladin was determined to have five engines erected overnight. The work on each engine was entrusted to a different component of his army

[529] Although the beam of *Arrangement D* is only 2 m less than that of *Arrangement A*, the shorter sling of the former is a mathematical handicap. In reality, sling length is one of the most easily altered mechanical variables, optimally determined by the proportions and masses of the other components but easily altered to adjust for range.

[530] Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 31-32, 88-89; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 149-50; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 384; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:355. For descriptions and discussions of the castle, see Chapter 7.

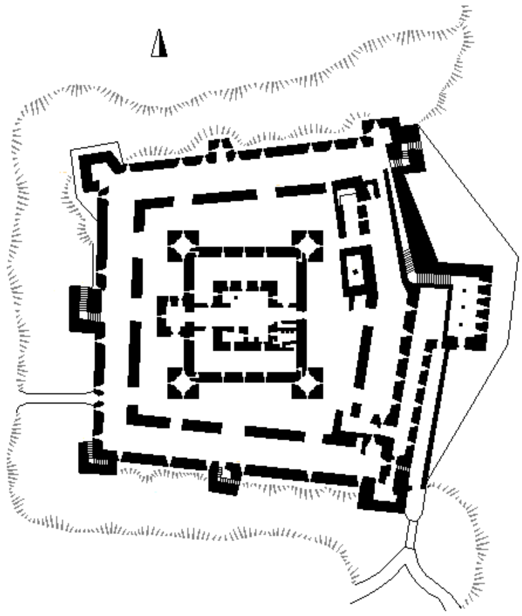
and by morning only the *khanazirs* were left to be fitted.[531] This description suggests that the engines were sizable enough to require significant teams to assemble them but small enough so as to be erected in less than 18 hours, roughly the same amount of time that it took Saladin's forces to erect artillery during the Syrian campaign a few months earlier. The Templar garrison sought terms on 30 November, their provisions exhausted from the extended blockade. From Safed, Saladin made for the Hospitaller castle of Belvoir.

Belvoir: Dec 1188

Belvoir, postdating 1168, was the most sophistically planned castle built by the Franks in Outremer during the twelfth century, planned in two concentric squares. It was constructed with basalt blocks hewn from the surrounding fosse and the outer wall is 3 m thick, provisioned with numerous posterns for rapid egress and a strong barbican to control ingress.[532] These defences were necessary as the castle could be approached easily from the south, west and north.

Saladin arranged his forces around the three approachable fronts of Belvoir and in the harsh November weather he erected his artillery. The sultan encamped so close to the castle that his tent was apparently within bow-shot of the garrison.[533] If accurate, this would suggest that Saladin positioned his artillery quite close to the castle, as these engines were almost certainly placed ahead of his tents. But although artillery was clearly used, it does not appear to have played a significant part in this siege; instead, it was frontal assaults and the mining of the eastern barbican that led the garrison to sue for terms on 5 January 1189. Saladin probably used his

Belvoir: castle, plan (after Benvenisti)

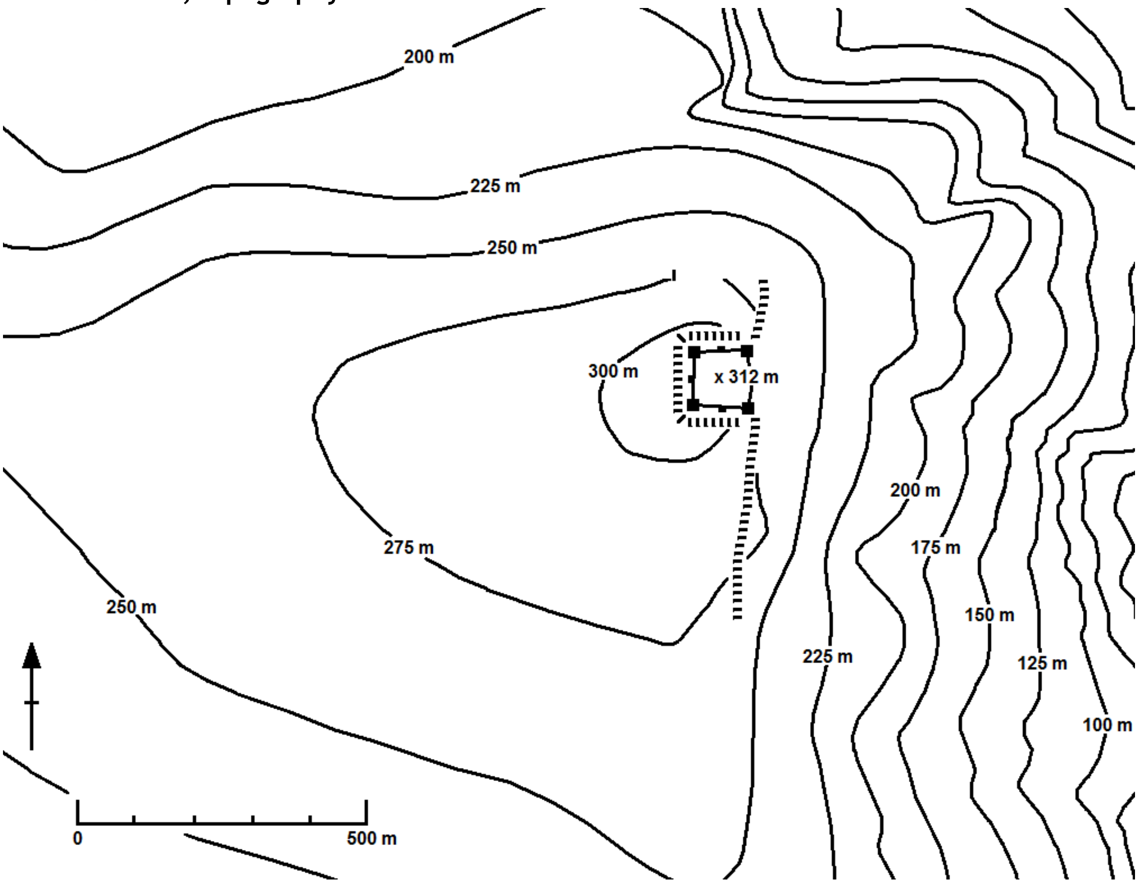


[531] The exact component that this term corresponds with is unknown, it might designate the sling or even a winch.

[532] For the layout of the castle see Conder and Kitchener, *Survey of Western Palestine*, 2:117-19; Benvenisti, *The Crusaders*, pp. 298-99. For the castle's construction, see Benvenisti, *The Crusaders*, pp. 299-300; Pringle, *Churches*, 1:123; France, *Western Warfare*, p. 92.

[533] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 89; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 152-53; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:356; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 387-88.

Belvoir: castle, topography



artillery to support his frontline forces, which might explain the apparent absence of artillery damage in the various accounts.

Like the north wall of Kerak, the surviving courses of masonry display few traces of the bombardment that took place in 1188-89. This would appear to be partly due to the limited force of the attacking engines but may also reflect the way in which the hard basalt fractures. Any impact signatures that might have been visible higher up the walls were obscured when the castle was slighted.[534] When the castle was cleared in the twentieth century, no note appears to have been taken of any spent projectiles, denying the opportunity to calculate the potential force with which they may have been thrown.

Frankish Palestine fell with Belvoir. When the campaign season of 1189 opened, Saladin moved his forces against Reynald of Sidon's mighty stronghold of Beaufort, perched high above the Litany River at the southern extent of Lebanon. Although the castle was approachable from all sides but the east, with an ideal plateau for artillery to the south, the *Eracles* account appears to be the only contemporary source that suggests

[534] This destruction took place either in 1192, or decades later under al-Mu'azzam 'Isa. For the former date, see Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 81. For the more likely latter, see Pringle, *Churches*, 1:120-22; Boas, *Crusader Archaeology*, pp. 106-8.

that artillery was used at this time. Most sources are far more interested in the episode of intrigue orchestrated by Reynald of Sidon to defer Saladin's assaults.[535] The siege was evidently more of a blockade and the garrison, even after its lord had been taken prisoner, was able to hold out until 22 April 1190, at which point it secured favourable terms of surrender. But by then Saladin's attention had been drawn elsewhere: the Frankish siege of Acre had begun.

The First Great Siege of Acre

Saladin had initially delayed releasing Guy of Lusignan, a prisoner since the battle of Hattin and whose liberty had been a term of Ascalon's surrender. Once freed and finding himself shut out of Tyre by Conrad of Montferrat, Guy and his supporters invested Acre from August 1189. With Acre's walls ahead of him, recently strengthened by Baha' al-Din Qaraqush al-Asadi, and Saladin to his rear, Guy had begun what would become the most protracted siege undertaken by Frankish forces in the Holy Land during the twelfth century.[536]

First Phase: 1189-90

Artillery does not appear to have been an immediate consideration of the Franks: the first notable assault was a frontal attack using ladders.[537] Although the motives for a rapid attack need no explanation, Saladin's arrival the day after this attack would have cut the Frankish force off from the larger trees beyond the plane of Acre, leaving them with the orchards around the city as their only source of timber. Only one source appears to date the construction of artillery to the autumn of 1189,[538] most others emphasise the Franks'

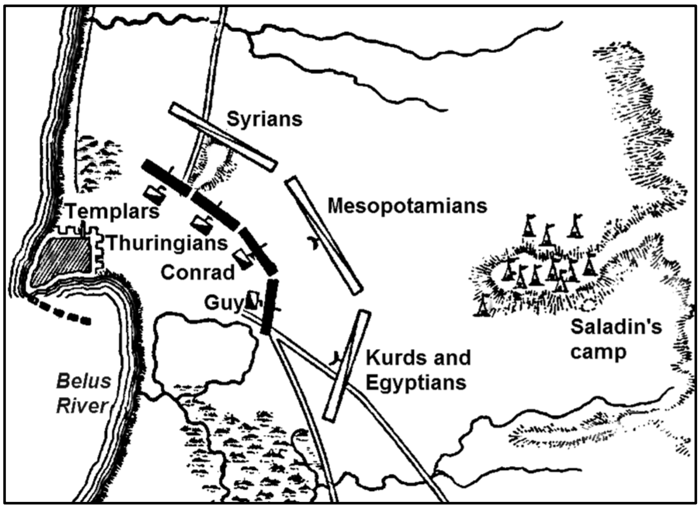
[535] *Eracles* 26.9, RHC Oc 2, pp. 187-88; Baha' al-Din, *al-Nawadir,* trans. Richards, pp. 90-91, 95-96, 97, 108; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 159-62, 210; Abu Shama, *Kitab al-Raudatain,* RHC Or 4, pp. 397-400, 441; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:360.

[536] *Eracles* 24.13-16, RHC Oc 2, pp. 123-27; *Itinerarium* 1.26-27, ed. Stubbs, pp. 61-63, trans. Nicholson, pp. 70-73; Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 91, 96-98; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 168-71; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:364-65.

[537] *Itinerarium* 1.27, ed. Stubbs, p. 62, trans. Nicholson, p. 71. For a complete breakdown of the Latin force's deployment, see Ralph of Diceto, *Ymagines historiarum*, ed. Stevenson, pp. 79-80; Roger of Howden, *Chronica*, ed. Stubbs, 3:20-22, trans. Riley, 2:126-28.

[538] Aymar the Monk, *Expeditione Ierosolimitana* ll. 81-104, ed. Falk and Placanica, pp. 8-10.

Acre region: deployment of forces, 1189 (after Oman)



efforts to entrench their siege camp. Defensively, the first mention of artillery appears to be in December 1189,[539] although their use is not mentioned until the spring of 1190.

During the first winter, the Franks filled a section of Acre's ditch and built three siege towers, commanded by Conrad of Montferrat and the Genoese, Guy of Lusignan, and Landgrave Ludwig II of Thuringia. These, according to the *Itinerarium*, were designed to resist defensive artillery. Furthermore, each contingent had a number of *petrariae* to support its tower as it advanced and to batter the walls near it.[540] Ambroise calls these engines, *pierieres* and *mangoniels*, and claims that the Muslim defenders made use of the same.[541] While it may appear conflicting that the same engines should be intended to provide cover for the advancing towers and target the walls, they could be seen to do both if they were used to target the parapet. Any damage done to the battlements would further expose any defenders.

Discerning the position and strength of these engines is further complicated when considering that Baha' al-Din claims that each siege tower was capped with a mangonel.[542] The *Itinerarium* states that this level was occupied, more sensibly, with archers and crossbowmen but fails to identify where the *petrariae* were placed. Roger of Howden locates them behind the Franks' earthworks, implicitly quite far from the siege towers.[543] These trebuchets were almost certainly less powerful than those used by Saladin in 1188: the best local wood and that scavenged from European ships would have

[539] *Itinerarium* 1.33, ed. Stubbs, pp. 77-79, trans. Nicholson, pp. 85-86; Ambroise, *Estoire* ll. 3,143-74, ed. Paris, pp. 84-85, trans. Ailes, p. 77; Aymar the Monk, *Expeditione Ierosolimitana* ll. 113-20, ed. Falk and Placanica, p. 12; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 430-31, 441-42; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 196-202; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:370; Baha' al-Din, *al-Nawadir*, trans. Richards, p. 109. See especially 'Imad al-Din, *al-Fath*, trans. Massé, pp. 201-2; Ambroise, *Estoire* ll. 3,205-22, ed. Paris, p. 86, trans. Ailes, p. 78.
[540] *Itinerarium* 1.36, ed. Stubbs, pp. 84-85, trans. Nicholson, pp. 90-91.
[541] Ambroise, *Estoire* ll. 3,191-222, ed. Paris, p. 86, trans. Ailes, pp. 77-78.
[542] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 110.
[543] Roger of Howden, *Chronica*, ed. Stubbs, 3:22, trans. Riley, 2:128.

been required to construct the three siege towers, leaving little choice lumber left for artillery.[544]

On 5 May 1190, the Frankish siege towers were advanced to the walls of Acre. The towers initially fared well against the stones and containers of Greek fire that were thrown against them, but this success was short-lived and by nightfall they were destroyed. According to the Muslim accounts, with the garrison's artillery failing to halt the advancing siege towers, Saladin permitted the son of a Damascene caldron-maker to approach Baha' al-Din Qaraqush, commanding the garrison, and concoct a mixture with which he intended to burn the towers. The incendiaries that he produced were then fired at the Frankish towers and consumed them in flames.[545] The Frankish sources give a far less dramatic account of this day's events, suggesting that the towers were burnt in a sally late in the day. Even if fanciful in their specifics, the Muslim accounts provide critical insight into how the defensive engines were employed.

'Imad al-Din and Ibn al-Athir give the impression that the first series of shots were made to gauge the range and accuracy of the responsible engine.[546] Once satisfied, the incendiary pots were cast against each tower in turn. Accuracy was critical to this exercise and adjustments would have been necessary whether the engine was traction- or counterweight-powered. Although it is tempting to judge the latter as the more likely given its accuracy once properly ranged, because the sources unanimously state that the towers had been pushed up to the edge of the fosse when they were burnt, they would have probably been within the range of a single traction trebuchet placed midway between them. A light traction trebuchet could also have been moved behind the curtain or from tower to tower to occupy an ideal position to target each siege tower in turn, mitigating the inherent inaccuracy of such an engine. The ability to move or elevate a traction trebuchet would also remove the complications that a small counterweight engine would face when trying to fire at a target so close to the curtain wall.

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[544] The use of imported wood is emphasised by the Muslim sources, see Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 447-48; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:372. See also 'Imad al-Din, *al-Fath*, trans. Massé, p. 214.

[545] 'Imad al-Din, *al-Fath*, trans. Massé, pp. 217-19; Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 110-11; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:373-74. See also *Itinerarium* 1.36, ed. Stubbs, p. 85, trans. Nicholson, p. 91; Ambroise, *Estoire* ll. 3,395-432, ed. Paris, p. 91-92, trans. Ailes, p. 80; Ralph of Diceto, *Ymagines historiarum*, ed. Stevenson, p. 83; Roger of Wendover, *Flores historiarum*, ed. Hewlett, 3:23, trans. Giles, 2:92; Aymar the Monk, *Expeditione Ierosolimitana* ll. 201-12, ed. Falk and Placanica, p. 20.

[546] 'Imad al-Din, *al-Fath*, trans. Massé, p. 218; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:373.

Short shots over an obstacle are harder for a counterweight trebuchet than they might first appear. They can be achieved either by increasing the release angle to produce a high trajectory shot or decreasing release velocity to maintain a more regular parabolic flight. The former requires less labour but shortens the firing sequence, making mechanical adjustments more sensitive, and extends a projectile's exposure to environmental influences. The latter requires that mechanical power be reduced by using a lighter counterweight. This is an inaccurate means of adjusting range that significantly increased the likelihood that the engine will misfire, as the projectile is accelerated more slowly and thus held in place by lower centrifugal and centripetal forces. Accordingly, there would have been a certain window of security for any siege tower once it was close enough to interfere with a more 'natural' flight trajectory but not quite close enough so that its top levels became exposed, no longer obscured by the curtain wall.

Second Phase: 1190

The arrival of Henry of Champagne, Theobald of Blois and a large party of French and English nobles, encouraged a second wave of siege engine construction, as well as Saladin's withdrawal to al-Kharuba on 1 August.[547] For the first time during the twelve months of the siege, the Franks initiated a significant artillery barrage.[548] From Baha' al-Din's account, it would appear that the barrage, maintained by teams working in relays, took a larger toll on Acre's defenders and moral than its fortifications. This seems sensible when considering that the ammunition at hand would have been almost exclusively the same soft *kurkar* sandstone that made up Acre's defences.

According to the Muslim sources, the garrison launched an initial sortie in late-August that successfully burnt two of the assailing stone-throwers. Henry's largest trebuchet appears to have escaped unscathed: still unfinished, it had not yet been brought forward. But it too fell victim to the garrison's pyrotechnics during another successful sally on the evening of 3 September, the flames then spread to an adjacent smaller trebuchet.[549] In what appears to be a different version of the latter incident, Baha' al-Din

[547] *Itinerarium* 1.42-43, ed. Stubbs, pp. 92-94, trans. Nicholson, pp. 97-99; Ambroise, *Estoire* ll. 3,505-20, ed. Paris, p. 94, trans. Ailes, pp. 81-82; Baha' al-Din, *al-Nawadir*, trans. Richards, p. 120; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 243-44; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:377.

[548] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 122; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 245; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 469-70; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:378; Ambroise, *Estoire* ll. 3,529-34, ed. Paris, p. 95, trans. Ailes, p. 82.

[549] Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 122-23; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 245-46; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:378. Cf. Ambroise, *Estoire* ll. 3,661-700, ed. Paris, pp. 98-99,

adds that arrows with burning tips were used to light one of the Franks' trebuchets on fire and that flames spread to another nearby engine.[550] Ibn al-Athir describes how Henry of Champagne, when attempting to build additional engines after the first sally, used a mound of earth to shield the two new trebuchets from Acre's archers. The mound was then advanced towards the walls until the engines, presumably those burnt in the second sally, were in a position to effectively fire against the city.[551]

If Chevedden's theory is correct, the use of the adjective 'great' found in certain Muslim accounts to refer to one or more of the Frankish trebuchets suggests that at least some of the assailing engines were counterweight trebuchets. Although there is no clear evidence to support or refute this, Baha' al-Din and Ibn al-Athir clearly state that the range of Henry of Champagne's trebuchets was less than that of Acre's archers. The latter's emphasis on the difficulties of constructing screens to shelter the crews working the Frankish artillery, rather than the engines themselves, speaks to the vulnerability of these individuals relative to the larger wooden engines next to them.

Baha' al-Din's claim that some trebuchets were completely set alight by incendiary arrows must be viewed critically as this would not have been an easy feat. The penetrating power of an arrow diminishes through the course of its flight, limiting the effectiveness of a heated arrowhead, or that of any incendiaries attached behind, against a relatively distant target.[552] Furthermore, the essential mobility of a trebuchet's beam allows for any incendiaries that might became lodged near the end of the long arm to be dealt with fairly quickly. It is in part due to this resilience to arrows that encouraged the use of defensive artillery, which could throw much larger incendiaries, and led to artillery battles.

The defensive artillery that appears during the events of May 1190 is described by Ambroise in one of his frequently quoted passages:

> There were within the city, as the historian tells us in truth, many catapults that hurled [missiles] so well that you never saw the like. There was one which was so powerful that it did us much harm, continually breaking into pieces our catapults and cerceleia, for it hurled the stones so that they flew as if they had wings; it took two men to load the sling, according to the written word, and then the sling let fly, when the stone fell, it had to be looked for a full foot into the ground. This very catapult struck a man in

trans. Ailes, p. 83; *Itinerarium* 1.54, ed. Stubbs, p. 105, trans. Nicholson, p. 109; Aymar the Monk, *Expeditione Ierosolimitana* ll. 405-20, ed. Falk and Placanica, p. 40.

550 Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 124-25.

551 Ibn al-Athir, *al-Kamil*, trans. Richards, 2:378.

552 The hardwood ideal for trebuchet components would have further resisted the penetration of any arrowheads, although it is questionable whether such wood would have been available to the Franks besieging Acre in 1190.

> the back and if the man had been a tree, or a column of marble, he would have been cut in half, but the good man did not feel it, for God did not permit it. One should have faith in such a Lord, for such a miracle inspires faith.[553]

Ambroise appears to suggest that the defenders of Acre possessed at least one trebuchet of comparable scale to the largest employed by the Franks. Instead of praising the size of this machine, likely concealed behind the town walls, he emphasises its accuracy and the size of its projectiles. The reference to the man who was struck but spared, resembling the incident at Wark in 1174,[554] should not be taken as a literal record of events but rather a piece of fiction to stress the engine's power but the even greater power of God, in whose name the crusaders were fighting. In its similar rendition of these events, the *Itinerarium* also draws attention to the power of this engine but highlights its size and range when adding that the individual who was struck believed that he was out of range.[555] Both accounts state that the Muslim artillery, and this exceptionally large engine in particular, was targeting the Frankish artillery as well as the shelters protecting those working to fill the town's fosse and the men defending them. While counterweight engines would have been well suited to targeting the immobile artillery and shelters, traction engines would have been much more effective at harassing the personnel around them.

Smaller defensive engines appear to have been used against the rams built by the archbishop of Besançon and Henry of Champagne. Frankish and Muslim sources state that artillery was used against these engines from the walls of the city on 14 October 1190.[556] Heavy artillery may have been used against the principal ram while it approached, but once close, the only engines capable of assailing it would have been those positioned on Acre's mural towers. From these towers, light artillery would enjoy

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553 *Il aveit dedenz la citié,* / *Co dit l'estorie en verité,* / *Mult perieres si bien jetantes* / *Que ainc ne vit l'en de tels tantes.* / *Une en i ot si jeteresse* / *Que trop esteit damajeresse,* / *Qui nus depecoit totes veies* / *Noz perieres e noz cercleies,* / *Car el getoit les pieres teles,* / *Volanz come s'eussent eles,* / *Que dous genz conveneit a metre* / *En la funde, sulonc la letre,* / *E quant la piere descendeit* / *E la funde aval la rendeit* / *Que bien plein pié parfont en terre* / *Al chaeir la coveneit querre.* / *Iceste meismes periere* / *Feri un home el dos deriere,* / *E si li hom devenist arbre* / *O une columpue de marbre,* / *Si l'eust el par me colpee,* / *Tant i fud el dreit acopee;* / *E li prodom ne la senti,* / *Car Dampnedeus nel consenti;* / *En itel seignor doit l'om creire,* / *Que tel miracle fait a creire.* Ambroise, *Estoire* ll. 3,535-60, ed. Paris, p. 95, trans. Ailes, p. 82.

554 Jordan Fantosme, *Chronique* ll. 1,240-55, ed. Howlett, pp. 307-8.

555 *Itinerarium* 1.47, ed. Stubbs, p. 98, trans. Nicholson, p. 103.

556 Ambroise, *Estoire* ll. 3,819-96, ed. Paris, pp. 102-4, trans. Ailes, pp. 85-86; *Itinerarium* 1.59, ed. Stubbs, pp. 111-13, trans. Nicholson, pp. 115-16; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 255-57; Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 130-31; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 485-86. Baha' al-Din misdates the assault to 4 October (3 Ramadan), rather than 14 October (13 Ramadan), so the ram and bore that he describes as being built by Frederick of Swabia, who arrived at Acre on the evening of 7 October, are likely equitable with the engines built by the archbishop and the count of Champagne.

sufficient room to operate and a good field of view to target anything assailing the base of the adjoining stretch of curtain.[557] While structural limitations would have prevented any attempts to mount heavy trebuchets on top of towers, the limited power of these engines is confirmed by their inability to significantly damage the ram. The heaviest stones thrown against the ram once it had reached the wall were likely dropped from the parapet above. This also offered the best angle to target the neck of the ram behind its iron head. The lighter tower-mounted traction trebuchets provided antipersonnel fire against any assailants bold enough to venture out of the ram while wood and incendiaries were dropped on and in front of it from the wall above. Disabled and burning, the archbishop's lumbering siege engine was eventually abandoned.

On the night of 4 Jan 1191 the first signs of damage appeared in Acre's walls when a section of the main curtain fell on the forewall ahead of it following a winter storm.[558] The Franks made an assault but were turned back and the defenders were able to patch the breach during the following days.[559] Artillery, in addition to archers, was used to protect the breach while it was being repaired, indicating that these were traction trebuchets. The inability of the Franks to exploit this gap in the walls, as well as its rapid repair, suggest that the damage did not extend far below the level of the parapet. Had the damage which led to this breach been caused by a large counterweight trebuchet in the lead up to the storm, it is inconceivable that the same engine would not have been able to repeatedly strike the same position, enlarging the breach or at least preventing its repair, let alone open a new one. Although the winter weather and wild temperature swings would have amplified any damage inflicted over the previous year, the breach may have been the result of a much older weakness in the structure, hidden within the masonry of the wall, which grew with each winter storm. While the siege of Acre continued into 1191, the principal leaders associated with the Third Crusade made their way to Palestine.

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[557] See **Fig. B23**.

[558] If accurate, this would appear to contradict Jacoby's theory that Acre was surrounded by only a single line of walls until the early thirteenth century, Jacoby, "Montmusard," pp. 207-17. Cf. Fulcher of Chartres, *Historia Hierosolymitana* 2.22.1, ed. Hagenmeyer, pp. 456-57, trans. Ryan, p. 174; Pringle, *Churches*, 4:5-6.

[559] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 142; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 277-78; Aymar the Monk, *Expeditione Ierosolimitana* ll. 557-68, ed. Falk and Placanica, pp. 54-56.

Third Phase: 1191

Before reaching the Holy Land, Richard I of England prepared his artillery, *perariae* and other engines according to Roger of Howden,[560] on Sicily during the early months of 1191. Experience in France had taught Richard the benefits of speed and preparedness on campaign while the landward blockade of the Christian force at Acre necessitated the importation of any materials that would be required during the siege. Richard also appears to have collected ammunition before departing Sicily: with the harder limestone beyond the coastal plain cut off by Saladin's forces, hard volcanic projectiles would have been far more effective against Acre's soft *kurkar* defences than projectiles hewn from the same type of stone.[561] Baha' al-Din appears to confirm Richard's importation of artillery when he notes the presence of engines of war, among other supplies, on a ship sent ahead to Acre that was intercepted off Beirut.[562] Richard was able to avenge this loss only weeks later when he intercepted a Muslim ship in the same area. Among the thirty-five men that Richard spared were experts at constructing siege machinery.[563] The only indication that Richard used his artillery before reaching Acre appears to be in Richard of Devizes's account of the siege of Buffavento on Cyprus; however, the sources more closely linked to these events do not corroborate this.[564]

Philip II of France arrived at Acre in mid-April 1191 as the siege was entering its third campaign season. Philip's siege strategy involved artillery from the outset. According to the *Itinerarium*, Philip erected *petrariae* and other engines opposite the Accursed Tower, which anchored the city's north east salient.[565] Roger of Howden also

560 Roger of Howden, *Chronica*, ed. Stubbs, 3:72, 105, trans. Riley, 2:174, 200.
561 Ambroise, *Estoire* ll. 4,791-4,800, ed. Paris, p. 128, trans. Ailes, pp. 98-99.
562 Baha' al-Din, *al-Nawadir*, trans. Richards, p. 147. Cf. 'Imad al-Din, *al-Fath*, trans. Massé, p. 292; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 8; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:386-87.
563 Ambroise, *Estoire* ll. 2,268-76, ed. Paris, p. 61, trans. Ailes, p. 64; *Itinerarium* 2.42, ed. Stubbs, p. 209, trans. Nicholson, p. 199. Cf. Roger of Howden, *Chronica*, ed. Stubbs, 3:112, trans. Riley, 2:206; Ralph of Diceto, *Ymagines historiarum*, ed. Stubbs, pp. 93-94; Aymar the Monk, *Expeditione Ierosolimitana* ll. 757-80, ed. Falk and Placanica, pp, 74-76. Ibn al-Athir's timing of events agrees with that in the Frankish sources; however, Baha' al-Din and 'Imad al-Din place the ship's capture on 11 June, after Richard's arrival at Acre, Ibn al-Athir, *al-Kamil*, trans. Richards, 2:387; 'Imad al-Din, *al-Fath*, trans. Massé, p. 299; Baha' al-Din, *al-Nawadir*, trans. Richards, p. 151.
564 Richard of Devizes, *Chronicon* 61, ed. Howlett, p. 425, trans. in *Chronicles of the Crusades*, p. 39. See also Peter of Langtoft, *Chronicle*, ed. and trans. Wright, pp. 66-67. Cf. Ambroise, *Estoire* ll. 2.009-13, ed. Paris, p. 54, trans. Ailes, p. 60; *Itinerarium* 2.39, ed. Stubbs, p. 202, trans. Nicholson, p. 194; Roger of Howden, *Chronica*, ed. Stubbs, 3:111, trans. Riley, 2:205; Ralph of Diceto, *Ymagines historiarum*, ed. Stevenson, p. 92.
565 *Itinerarium* 2.28, ed. Stubbs, p. 181, trans. Nicholson, pp. 177-78. See also Ambroise, *Estoire* ll. 1,341-45, ed. Paris, p. 36, trans. Ailes, p. 50; Aymar the Monk, *Expeditione Ierosolimitana* ll. 729-40, ed. Falk and Placanica, pp. 70-72.

notes Philip's initial use of artillery but specifies that these engines made no impact on the town's defences while he waited for Richard to arrive.[566]

The Muslim sources claim that the Franks pressed Acre from 30 May with seven trebuchets. Saladin was able to interrupt the barrage when he advanced his forces from their wintering position and attacked the Frankish siege camp but the relentless bombardment resumed when his forces retired to rest.[567] While the Franks continued their attempts to fill the ditch around Acre, the defenders divided themselves into four teams: one cut up the debris in the fosse, another threw it into the sea, a third stood guard and a fourth provided cover with artillery (traction trebuchets).

Richard landed at Acre on 8 June 1191, by which point, twenty-one months after the siege had begun, damage was becoming visible on one of the city's towers. Despite being struck down with a bout of illness, he saw to the deployment of *petrariae*, *mangunelli* and a *castellum*, which was erected in front of one of the city's gates.[568] Frankish artillery played against the walls of Acre throughout June 1191. 'Imad al-Din states that most damage was sustained at the level of the parapet, though in some sections Acre's walls were reduced to the height of a man.[569] Similarly, Baha' al-Din notes that the Franks placed increasing focus on their artillery and increased the mass of their projectiles as much as they could, adding to the mental strain sustained by the garrison.[570] Although 'Imad al-Din is a particularly difficult source to deal with, both he and Baha' al-Din appear to suggest that while lighter engines continued to suppress any defenders along Acre's ramparts, the heaviest engines targeted the integrity of the walls. The ability of the defenders to continually repair their damaged battlements was critical to their ability to maintain an effective defence; however, enough damage had apparently been inflicted by the start of July that the French forces felt confident enough to make a frontal assault.

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[566] Roger of Howden, *Chronica*, ed. Stubbs, 3:113, trans. Riley, 2:207.

[567] Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 147,148-50; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 293-94, 295-97; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 10; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:387.

[568] *Itinerarium* 3.4, ed. Stubbs, p. 214, trans. Nicholson, p. 204. Richard of Devizes states that the *castellum* was the same that Richard had disassembled before leaving Sicily, and it is likely the same armoured siege tower that the Muslim sources claim was burnt later in June and that which Ambroise and the *Itinerarium* mention among the events of late June and early July, Richard of Devizes, *Chronicon* 28, 64, ed. Howlett, pp. 403, 426-27, trans. in *Chronicles of the Crusades*, pp. 21, 41; Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 151-52; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 299-300; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:387; Ambroise, *Estoire* ll. 4,773-84, ed. Paris, p. 128, trans. Ailes, p. 98; *Itinerarium* 3.7, ed. Stubbs, p. 219, trans. Nicholson, p. 209.

[569] 'Imad al-Din, *al-Fath*, trans. Massé, pp. 306-8, 310-11, 314-15.

[570] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 156.

Acre was hosting a veritable convention for some of Europe's most powerful figures to demonstrate their prowess through the construction of siege engines. Philip of France had one trebuchet, named *Male Veisine*/*Mala Vieina*, which drew the fire of one of the garrison's best engines, dubbed *Male Cosine*/*Mala Cognata*, possibly the same defensive engine noted elsewhere during the autumn of 1190. The latter was able to knock the former out of commission on a number of occasions but it was repeatedly rebuilt and continued to fire against the Accursed Tower and adjoining stretches of curtain. Although this is the only one of Philip's trebuchets that is mentioned, he likely had other lighter ones. Hugh of Burgundy, the Templars, and the Hospitallers each had a notable trebuchet and another was funded communally. Philip of Flanders, veteran of the siege of Harim in 1177, had a choice trebuchet along with a smaller one, both of which were appropriated by Richard following the count's death. Richard directed these two against a gate, presumably that which his *castellum* faced, and erected another two *perieres*/*petrariae*, likely those prepared on Sicily, and two *mangonels*/*mangunelli*.[571] This breakdown supports the Muslim sources' claims that seven engines were used by the Franks from the end of May 1191, making Bar Hebraeus's remark that the Franks used seven engines after Richard's arrival only slightly misdated.[572] From mid-June, nine notable *petrariae* and at least two *mangunelli* were in use.

For practical reasons, most of the trebuchets erected by the Franks through 1189-91 were probably traction-powered; however, this does not mean that the engines enumerated in the summer of 1191 were such. The wealth and resources of the European potentates and the natural competition between them for prestige make it likely that the trebuchets constructed in 1191 were particularly impressive for their time. But although this is suggestive it is far from definitive.

According to Ambroise, Richard was able to damage the top of the gate tower that he targeted with Philip of Flanders' engines. The same author states that Philip II's principal engine was able to inflict significant damage on the Accursed Tower and adjoining curtain, while the communal engine did further damage to a section of wall next to this tower, presumably on the other side of it.[573] Similarly, Roger of Howden states

[571] Ambroise, *Estoire* ll. 4,737-800, ed. Paris, pp. 127-28, trans. Ailes, pp. 98-99; *Itinerarium* 3.7, ed. Stubbs, pp. 218-19, trans. Nicholson, pp. 208-9. See also Roger of Howden, *Chronica*, ed. Stubbs, 3:111, trans. Riley, 2:205; Aymar the Monk, *Expeditione Ierosolimitana* ll. 785-88, ed. Falk and Placanica, p. 76.
[572] Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 2:334.
[573] Ambroise, *Estoire* ll. 4,749-51, 4,759-76, ed. Paris, pp. 127-28, trans. Ailes, p. 98. Cf. *Itinerarium* 3.7, ed. Stubbs, pp. 218-19, trans. Nicholson, p. 209.

that the *perrariae* of the French king, the Templars and the Pisans opened a breach near the Accursed Tower and it was here that the French rushed the walls but were turned back in early July.[574] Ralph of Diceto is less specific, noting that walls were worn down by the assailing machines and *petrariae* but not where this damage was concentrated.[575] Despite the universal reports of destruction, which support the likelihood that counterweight trebuchets were used, the emphasis placed on the danger faced by members of the garrison when attempting to man their defences, suggest a range of artillery was used. Repeated references to cerclieas (shelters for attacking archers) are a reminder that the parapet, although damaged in sections, remained largely defensible in July 1191.

The descriptions of Richard's engines provided by Ambroise and the *Itinerarium* are important to any discussion of terminology.[576] One of the projectiles loosed by one of Richard's *perieres*/*petrariae*, a river stone brought from Messina, is supposed to have killed twelve of Acre's defenders. The stone was then taken to Saladin for inspection.[577] The notion that either source could have seen the impact of this stone is as unlikely as the possibility that a swimmer would have smuggled the stone out of the city during the peak of the siege. The responsible engine was probably relatively heavy: although the projectile supposedly killed a group of people, rather than destroying a notable section of fortification, their number suggests that it is the size of the stone that the authors are trying to emphasise. Furthermore, the use of imported ammunition bears clear similarities to the Sicilians' use of such at Alexandria in 1174, as reported by 'Imad al-Din and subsequent Muslim sources.[578] These special stones were likely used by the most powerful engines to transfer as much energy as possible to their targets and fired at a correspondingly slow rate. Fieldstones would suffice for antipersonnel fire. This, along with the apparent damage caused by Philip of Flanders's larger engine and that inflicted by the communal engine and that of Philip II, suggest that the terms *perieres*/*petrariae* were used by these authors to describe the heaviest artillery, but not necessarily exclusively.

If the two *perieres*/*petrariae* that Richard erected at Acre were counterweight trebuchets, it is tempting to try and distinguish them from the two *mangonels*/*mangunelli*.

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[574] Roger of Howden, *Chronica*, ed. Stubbs, 3:116-17, trans. Riley, 2:210-11.
[575] Ralph of Diceto, *Ymagines historiarum*, ed. Stevenson, p. 94.
[576] Ambroise, *Estoire* ll. 4,767-800, ed. Paris, pp. 127-28, trans. Ailes, pp. 98-99; *Itinerarium* 3.7, ed. Stubbs, pp. 219-20, trans. Nicholson, p. 209.
[577] Cf. the description of a stone killing three of Tortosa's defenders in 1155, Otto of Freising and Rahewin, *Gesta Friderici I* 2.21, ed. Waitz, p. 124, trans. Mierow, p. 135.
[578] Abu Shama, *Kitab al-Raudatain*, RHC Or 4, pp. 165-66.

Unfortunately the only description of the latter is that one was particularly swift, and possibly capable of firing its projectiles across an impressive distance.[579] Swiftness is a characteristic attributable to a traction trebuchet but a remarkable range is not. It is possible that Ambroise used *mangonels* as a synonym for *perieres* in order to rhyme with *ignels*; however, later events suggest that these engines are distinct from the four *perieres*. Fitting with the machines' reported swiftness, Ambroise's remark that *Quant sa piere voleit en Acre, Qu'ele aloit jusqu'en la maçacre* may refer to an area of more general slaughter, such as the parapet, rather than to a specific area within the city associated with a butcher (*macel*), such as that identified near the harbour by Philip of Novara decades later.[580]

The comparable damage inflicted by the other enumerated *perieres*/*petrariae* suggests that these were counterweight trebuchets similar to those of Richard. With Frankish numbers at their highest since the siege began, the Franks might have felt comfortable advancing their engines relatively close to the curtain in order to fire particularly heavy projectiles. By using a lower trajectory and sacrificing release velocity for additional force and mechanical efficiency, a greater amount of energy would be transferred upon impact. The masonry would have been forced to absorb this added energy, manifesting in shockwaves that would break apart the bonds of the stone and mortar as they reverberated out from the point of impact. But despite the probable power of these engines, the term *perriere*/*petraria* does not appear to have been exclusively used to denote counterweight trebuchets, as it was also applied to the lighter engine used against Philip's 'cat',[581] similar to, if not the same as, those that had fired on the Frankish ram in the autumn of 1190.[582]

The primary breaching weapon of the Franks was their sappers, who worked to undermine Acre's defences from late June 1191, if not earlier.[583] It is an unexplored possibility that Philip and Richard may have used their heavy artillery to assist the

[579] *Si fist fiare dous mangonels,* / *Dont li uns esteit si ignels,* /*quant sa piere voleit en Acre,* / *Qu'ele aloit jusqu'en la maçacre*. Ambroise, *Estoire* l. 4,787-90, ed. Paris, p. 128, trans. Ailes, p. 98, trans. Hubert, pp. 202-3.

[580] Philip of Novara, *Gestes des Chiprois* 138, ed. Raynaud, p. 50, trans. La Monte, p. 91. See also Ambroise, *Estoire*, trans. Ailes, p. 98 n. 332, trans. Hubert, p. 203 n. 22.

[581] Cf. the επιβαθρα, Vitruvius, *De architectura* 10.13.8, ed. Krohn, p. 253.

[582] Ambroise, *Estoire* ll. 4809-40, ed. Paris, pp. 127-28, trans. Ailes, p. 99; *Itinerarium* 3.8, ed. Stubbs, pp. 220-21, trans. Nicholson, p. 210.

[583] Ambroise, *Estoire* ll. 4,841-5,040, ed. Paris, pp. 129-35, trans. Ailes, pp. 99-102; *Itinerarium* 3.9-14, ed. Stubbs, pp. 221-28, trans. Nicholson, pp. 211-16; Roger of Howden, *Chronica*, ed. Stubbs, 3:115, 116, 118-20, trans. Riley, 2:209-10, 212-14. Cf. Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 156-58, 160; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 306-13, 314-18.

sappers, working against the notoriously strong mortar of this region. Both kings attempted to undermine the same towers that their artillery was targeting, perhaps using the percussive force of their artillery to spread small fractures through the mass of the wall being undermined, facilitating the collapse of these sections when the mines were set alight. Philip of France appears to have done this in reverse during the final stages of his siege of Chateau Gaillard in 1204. Using a *petraria* called *Cabulus*/*Chadabula*, he knocked down a weakened section of the inner bailey that had been undermined but had not fallen completely.[584] By 12 July 1191, the garrison was no longer confident that it could withstand the Frankish assaults and surrendered before the town could be taken by force.

Legacy

"For if the ten-year war made Troy famous, and the Christian triumph made Antioch more illustrious, then Acre will certainly win eternal fame for the whole globe assembled to fight for her."[585] Perhaps more than any other aspect of this extraordinary siege, it is the use of artillery during its final phase that has attracted the attention of historians. Although it is popularly held that counterweight trebuchets were employed, the evidence supporting this remains at best circumstantial. No new terminology is used by any of the eyewitness sources and similar descriptions of artillery damage can be found at a number of earlier sieges; however, the wealth of the figures involved, the importation of prefabricated engines and ammunition and what appears to be the use of both heavy and light artillery, make it very likely that both traction and counterweight trebuchets were used.

A commendable evaluation of the artillery used at Acre in 1191 has been put forward by Randal Rogers.[586] Considering the various descriptions of destruction in the sources, Rogers suggests that there is little firm evidence upon which to support any conclusions regarding the power source of these machines and instead emphasises the impact that they seem to have had on the city's fortifications. But this approach can be misleading as descriptions of artillery smashing fortified masonry can be found throughout the classical and medieval periods and even light engines would have left an impression in the soft *kurkar* after two years of bombardment. Apart from 'Imad al-Din, the sources agree that mining was the greatest threat to Acre's fortifications.

[584] William the Breton, *Gesta Philippi Augusti*, ed. Delaborde, p. 219.
[585] *Itinerarium* 1.32, trans. Nicholson, p. 83.
[586] Rogers, *Latin Siege Warfare*, pp. 227, 234-35.

Instead of relying on colourful and easily exaggerated adjectives and adverbs, the manner in which the engines at Acre were deployed should be stressed. But even when considering relative ranges, targets and the presence of imported ammunition, Rogers' conclusion holds firm: there is a lack of material evidence to quantify the power of the artillery that was used. Dispelling this caution, numerous historians have seized the chance to state unhesitatingly that counterweight trebuchets were employed at Acre, relying on no more evidence than a literal reading of the sources discussed above.[587]

Modern historians can be forgiven to some degree for their uncritical reading of the sources as some subsequent medieval authors added further embellishment or injected descriptions suited to their own context into their accounts. James of Vitry, writing only a few decades later, left a powerful, if brief, account of the siege which emphasises the kings' use of artillery and does not mention mining.[588] A similar description of what appear to be more powerful engines and larger projectiles than are described by the eyewitness sources, can also be found in Peter of Langtoft's later account, although this author makes it clear that mining was the impetus for the city's surrender.[589]

Despite the apparent power of certain engines at the siege of Acre, it is important to observe the consistent manner in which artillery was used throughout the twelfth century. As at Nicaea and Jerusalem in the last years of the eleventh century, the besieging artillery used at Acre appears to have targeted the city's parapets. This in itself should check any tendency to see these weapons as breaching engines, even if the heavier ones were now deliberately targeting the battlements and tops of walls rather than those defending them. Evidence to suggest that reciprocally heavy engines were commonly employed in defence is scarce; however, it would appear that garrisons were increasingly employing artillery as part of a more comprehensive defence. Although the tower-mounted engines employed at Acre did not disable the ram used in 1190 or Philip's 'cat'

[587] Benvenisti and Nicolle do this without apparently considering any other alternative, while Chevedden, operating on the premise that such engines were employed much earlier in the twelfth century, sees the descriptions of destruction as ample evidence of the use of counterweight trebuchets, Benvenisti, *The Crusaders*, pp. 284-85; Nicolle, "The Early Trebuchet," p. 272; Chevedden, *Citadel of Damascus*, p. 279.
[588] "King Philip of France battered the city walls, towers, and battlements incessantly, both by day and by night, with huge stones, breaking the enemy's machines, houses, and buildings within the city, and giving the besieged no rest. On the other side, the King of England frequently made perilous assaults on the besieged; wherefore, as the wall was giving way under the continual strokes of the great stones flung against it, the citizens, perceiving that they could not much longer resist, surrendered the city..." James of Vitry, *Historia orientalis* 99, ed. Donnadieu, p. 454, trans. Stewart, p. 112.
[589] Peter of Langtoft, *Chronicle*, ed. and trans. Wright, pp. 80-81.

in 1191, their use reflects more systematic defensive planning than appears to have been in place at the start of the century.

Late Sieges of the Crusade

Darum: 1192

After Acre had fallen, Richard I of England disassembled his artillery and prepared it for transport.[590] The king does not appear to have had the opportunity to use these engines until the following year as most of the coastal defences and those of southern Palestine, with the notable exception of Jerusalem, were slighted by the time the crusader army arrived.[591] With the 1192 campaign season opening, Richard led a reconnaissance force from Ascalon to Gaza on Easter Tuesday and onward to Darum the following day.[592] The original small quadrangular castrum described by William of Tyre had grown since its initial foundation and the apparently weak outer defences that Saladin had faced in 1170 had been rebuilt. By 1192 the stronghold boasted seventeen towers and a fosse.[593]

Richard grew impatient waiting for the French and Eastern Frankish forces to prepare themselves, appreciating that Saladin had been mustering his army since early April. He decided to march what forces he had at Ascalon to Darum, which was still occupied by a Muslim garrison, and besieged the outer defences from Tuesday 18 May 1192. Although Richard's force was unable to surround the stronghold, it was able to deploy its artillery, which had been moved by sea and alighted about 2 km up the coast. The prefabricated components of three machines were then reassembled in position. These may have been the two *petrariae* that Richard had assembled at Acre and the notable trebuchet that the count of Flanders had built before his death. Richard maintained command of one of these engines while contingents from Normandy and Poitou each

[590] Ambroise, *Estoire* ll. 5,379-82, ed. Paris, p. 144, trans. Ailes, p. 106; *Itinerarium* 4.2, ed. Stubbs, p. 240, trans. Nicholson, p. 227. Cf. Roger of Howden, *Chronica*, ed. Stubbs, 3:122, trans. Riley, 2:215.

[591] Ambroise, *Estoire* ll. 5,980-84, 6,835-69, ed. Paris, pp. 160, 183, trans. Ailes, pp. 114, 124-25; *Itinerarium* 4.14, 23, 32, 35, ed. Stubbs, pp. 256, 297-98, 280, 303, trans. Nicholson, pp. 242, 261, 274-75, 278; Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 177-80, 181, 183; 'Imad al-Din, *al-Fath*, trans. Massé, pp. 231, 345-48; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 462, RHC Or 5, pp. 40, 43-44, 50-51; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:391, 392.

[592] *Itinerarium* 5.7, ed. Stubbs, pp. 318-19, trans. Nicholson, pp. 289-90.

[593] William of Tyre, *Chronicon* 20.19, ed. Huygens, 2:937, trans. Babcock and Krey, 2:372-73; Ambroise, *Estoire* ll. 9,223-29, trans. Ailes, p. 156; *Itinerarium* 5.39, ed. Stubbs, p. 353, trans. Nicholson, p. 317.

commanded another. As at Acre, Ambroise's version of events emphasises the fear that these engines impressed on the garrison while the *Itinerarium* stressed their destructive force.

The trebuchets are portrayed as being quite powerful yet at least Richard's engine was used to provide cover for the sappers who worked to undermine the largest of the mural towers. It can be assumed that Richard's artillery was once more targeting the battlements and the defenders' artillery – an engine which had been set up on top of the large tower that was being undermined was knocked out of action by the engine commanded by the king. One of the other attacking engines targeted a gate, which it reportedly damaged. Like the gate that Richard targeted with Philip of Flanders' engines at Acre, this might have been to prevent the garrison from making a sally, as was done at the Bridge Gate during the siege of Antioch in 1097-98. The position of the third engine is unclear.[594]

The garrison sought terms on the morning of the fourth day of the siege. Refusing to accept anything less than an unconditional surrender, Richard renewed the barrage. The tower that that was being undermined was so weakened by this point that a sizable portion collapsed when the engine commanded by the king renewed its barrage. As the resulting breach was stormed, the garrison withdrew to a tower and surrendered from there before the day ended.[595]

Although this episode reinforces many of the principles that can be discerned from the siege of Acre, there is no clear description of these engines and thus no definitive evidence of what form these engines took. Although the use of one engine to bring down a tower implies that it is quite powerful, the Frankish sources clearly state that it was only able to do so because the tower was already undermined. Revealingly, 'Imad al-Din and Baha' al-Din emphasise Richard's use of miners and omit any mention of artillery, though they confirm the brevity of the siege.[596]

[594] Ambroise, *Estoire* ll. 9,151-262, ed. Paris, pp. 245-48, trans. Ailes, pp. 155-56; *Itinerarium* 5.39, ed. Stubbs, pp. 352-54, trans. Nicholson, pp. 316-17.

[595] Ambroise, *Estoire* ll. 9,288-373, ed. Paris, pp. 248-51, trans. Ailes, pp. 157-58; *Itinerarium* 5.39, ed. Stubbs, pp. 354-56, trans. Nicholson, pp. 318-19. Cf. Roger of Howden, *Chronica*, ed. Stubbs, 3:180, trans. Riley, 2:266.

[596] 'Imad al-Din, *al-Fath*, trans. Massé, pp. 378-79; Baha' al-Din, *al-Nawadir*, trans. Richards, p. 201; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 54.

Jaffa: 1192

While Richard moved on Beirut the following year, another coastal city to which artillery could be moved via his fleet, Saladin moved on Jaffa. The Muslims arrived on 27 or 28 July 1192 and the siege began the following day.[597] The Frankish sources claim that the first three days of the siege were consumed with fighting in the suburbs around Jaffa until, on the fourth day, Saladin brought artillery into play. This, according to Ambroise, consisted of four strong and light *perieres* and two *mangunels*, or, according to the *Itinerarium*, four notable and effective *petrariae* and two fast-firing *mangunelli*. The adjectives used to describe these engines suggest technical difference between the two types. While the *mangunelli* would appear to have been traction trebuchets, references by these sources to tower-mounted *petrariae* and the supposed difficulties encountered by Jaffa's defenders when attempting to operate additional *petrariae* should discourage any inclination to impose terminological guidelines too strictly.[598] References to powerful 'fast-firing trebuchets' at Toulouse in the second decade of the thirteenth century complicate matters further.[599] But it is perhaps the number of engines noted by the sources that most exposes them to question: the same compliment of engines was assigned to Richard at Acre. Furthermore, the measure of the breach reportedly created near the eastern gate, two perches (about 10 m), is the same as the extent of the damage inflicted by the communal engine at Acre a year earlier.[600]

Baha' al-Din, a participant of this siege, provides the best account from the Muslim perspective. According to him, Saladin intended to employ artillery from the start, having his

Jaffa: town, from the north (de Bruyn, 1681, from Schiller)

[597] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 217. The Frankish sources place these events one day earlier than the Muslim accounts, Ambroise, *Estoire* ll. 10,807-10, ed. Paris, p. 289, trans. Ailes, p. 175; *Itinerarium* 6.13, ed. Stubbs, pp. 400-1, trans. Nicholson, p. 349.
[598] Although counterweight trebuchets were mechanically more complex than the traction variety, they were much easier to operate accurately.
[599] *Chanson de la croisade Albigeoise* 192, ed. Meyer, 1:285, trans. Shirley, p. 141.
[600] Ambroise, *Estoire* ll. 10,811-49, ed. Paris, pp. 289-90, trans. Ailes, pp. 175-76; *Itinerarium* 6.13, ed. Stubbs, p. 401, trans. Nicholson, pp. 349-50.

forces erect his trebuchets near Jaffa's eastern gate. He claims that this section of fortifications had been damaged during an earlier siege, more probably when the town was slighted in 1190, but had since been partly repaired.[601] Sappers were able to excavate an area under the weakened fortifications on the first day but the defenders successfully collapsed this mine before it could bring down a section of wall. Two trebuchets came into action on the morning of the second day of the siege and a third was ready later in the day. Although the sappers had begun to undermine a longer section of the town's defences, Saladin's forces became disheartened as they were well aware that their artillery could have little effect before Richard arrived with relief. Even Saladin became worried after the extended mines brought down a part of the curtain but the improvised defences of the garrison proved sufficient to repel the attacks of his forces. That night, he resolved to have five trebuchets erected, either two more to bring his total to five or five more to bring his total to eight. The engines were ready by the morning of the fifth day of the siege (31 July), by which point stones had been scavenged from riverbeds and distant places for them to throw. Although Baha' al-Din claims that the engines were to be used to target the weakened curtain wall, the trebuchets are portrayed as supporting the attacks that were made that day, while it is the miners that were clearly responsible for bringing down the section of wall that allowed the Muslims to storm the town.[602] Having taken the town, Saladin does not appear to have used his artillery against the citadel, still without battlements since it was slighted in 1190.

The Muslim and Frankish accounts loosely align, from the fighting beyond the walls and the eventual breach, to the notable number of Muslim trebuchets. Although artillery is portrayed as a showpiece, it was the work of the miners that compromised the besieged defences, as at Acre and Darum. It is hard to assess Saladin's artillery. The gathering of distant stones for ammunition can be interpreted in two ways: either that Saladin needed harder stones, such as limestone from the Judean-Samarian hills to the east, for counterweight trebuchets, which targeted the walls of Jaffa; or, that he was running out of field stones to feed his rapidly firing traction trebuchets. A literal reading of the sources would suggest the former; however, Baha' al-Din's explicit statement that no stones were found around the town, and the use of these engines in conjunction with the frontal assaults might support the latter.

[601] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 217. Cf. 'Imad al-Din, *al-Fath*, trans. Massé, p. 231.
[602] Baha' al-Din, *al-Nawadir*, trans. Richards, p. 217-20. See also 'Imad al-Din, *al-Fath*, trans. Massé, pp. 384-85; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 67-68.

The period from 1187 to 1192 is an interesting and tumultuous one, documented by sources that were close to the figures and events. Their treatment of artillery over the five years between the battle of Hattin and the siege of Jaffa is enlightening. Although few mechanical descriptions are provided, the detailed week-to-week and day-to-day accounts reveal how these engines were used, if not the specifics of their design. The apparent use of prefabricated artillery by Saladin and Richard I conveys a sense of value while Saladin's campaign through Syria appears to reveal certain limitations of these engines. The increasing use of what appear to be heavier engines in conjunction with mining, supplementing rather than replacing lighter antipersonnel engines, is revealed to be a popular tactic when the topography allowed.

At the end of the twelfth century, the heaviest artillery was still incapable of breaching fortifications; however, there is evidence that it was being used to target defensive masonry, even if this was the thinner masonry of battlements. Defensively, light traction trebuchets were still popularly employed. Although most appear to have been no more powerful than those used a century earlier, there are indications that heavier engines may also have been given a defensive function. The continued development of the heaviest engines would soon provide them with a definitively new role, entirely distinct from the antipersonnel function of lighter traction engines.

6. Artillery in the Ayyubid Period
New Terminology (1192-1260)

On average, the Franks were engaged in fewer sieges each year during the first half of the thirteenth century than they had been during the twelfth. The Third Crusade had allowed them to recover a small coastal strip of Palestine but little territory beyond this. Less than six months after Richard I had left the Holy Land, Saladin died and a sixty-year power struggle between the potentates of Cairo, Damascus and Aleppo ensued, with the Franks of Acre an occasional fourth party. But throughout this period of intra-Ayyubid conflict, there are only a few points at which the use of artillery can be analysed.

The Fifth Crusade

The first period of Frankish expansion in the aftermath of the Third Crusade coincided with a German crusade in 1197-98. There seem to be no indications that these forces used artillery when Sidon, Jubayl and Beirut were acquired nor at the unsuccessful siege of Toron.[603] Similarly, there is little to suggest that artillery was employed by al-'Adil when he took Jaffa in 1197, besieged Mardin in 1198 and 1203, attacked Crac des Chevaliers

603 James of Vitry, *Historia orientalis*, ed. Donnadieu, pp. 452-54, 464, trans. Stewart, pp. 111, 117-18; Arnold of Lubek, *Chronica Slavorum*, ed. Pertz, pp. 200-1, 205-7, 209-10; Wilbrand of Oldenburg, *Itinerarium terrae sanctae* 1.5, ed. Pringle, p. 118, trans. Pringle, p. 65; letter of the Duke of Lorraine to the Archbishop of Cologne (1197), ed. Pertz, *Annales Colonienses Maximi*, p. 805, trans. Munro, in *Translations and Reprints* 5.1, vol. 1.4, , pp. 22-23; *Eracles* 27.6-7, 9, RHC Oc 2, pp. 224-26, 227; Roger of Howden, *Chronica*, ed. Stubbs, 4:28-29, trans. Riley, 2:406-7; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 462, RHC Or 5, pp. 117-18; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 102, 123; Philip of Novara, *Gestes des Chiprois* 127, ed. Raynaud, pp. 41-42, pp. 678-79, trans. La Monte, pp. 78-79; Deschamps, *Les Châteaux*, 2:225 n. 1; Müller-Wiener, *Castles of the Crusaders*, p. 70.

and Tripoli in 1207, or at the five Ayyubid sieges of Damascus between 1194 and 1201.[604] Despite the lack of references to artillery in these instances, it was certainly employed during the Fifth Crusade.

Mount Tabor: 1217

Crusading armies under Andrew II of Hungary and Leopold VI of Austria arrived in the Levant in 1217. These forces, with Hugh of Cyprus, John of Brienne, king-regent of Jerusalem, and sizable contingents of the military orders, launched three raids from Acre into Galilee that year. The second of these was directed towards Mount Tabor, fortified by al-'Adil to oppose Frankish incursions stemming from Acre.[605] The exact details of this episode are not clear but it appears to have been more of an attack than a concerted siege: the garrison made a pre-emptive assault against their assailants and then held off a subsequent Frankish frontal attack. Sibt ibn al-Jawzi claims that the defenders threw Greek fire to hold off the Franks, but this was probably thrown by hand.[606] Ibn al-Athir is the only source who mentions artillery, claiming it was used by the Franks.[607] Although the Franks may not have used artillery at Mount Tabor, its use against Damietta soon after reveals the full potential of artillery at this point in history.

Damietta: 1218-19

Tactically, Damietta offered many of the same options to a besieging force as did most cities along the Palestinian littoral: although its western front was protected by a branch of the Nile and Lake Manzala secured it to the east, it was easily approached from the

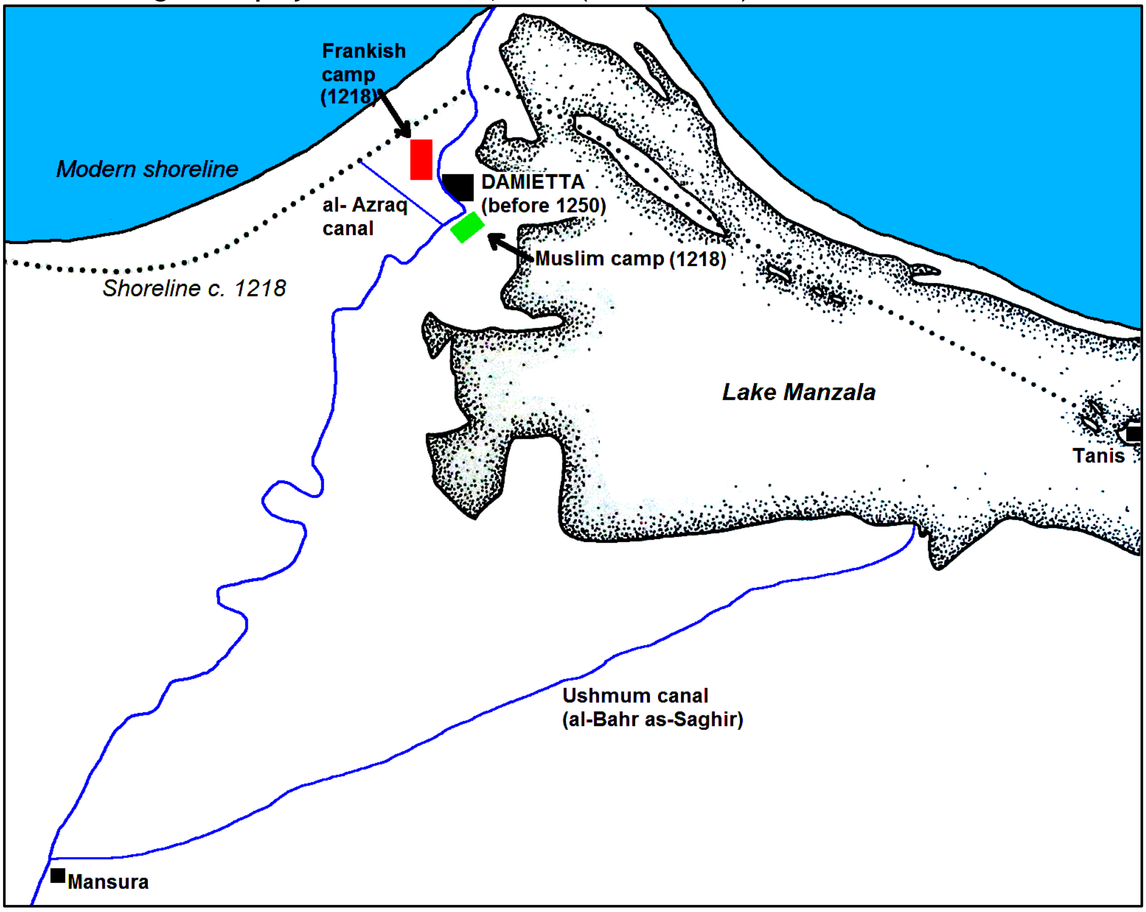
[604] *Eracles* 27.3, RHC Oc 2, pp. 219-20; James of Vitry, *Historia orientalis*, ed. Donnadieu, pp. 464-66, trans. Stewart, p. 118; Roger of Howden, *Chronica*, ed. Stubbs, 4:25-26, trans. Riley, 2:404-5; Arnold of Lubek, *Chronica Slavorum*, ed. Pertz, p. 204; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 118-19, 152; Ibn al-Athir, *al-Kamil*, trans. Richards, 3:67; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 118-19, 123-24, 144.

[605] Ibn al-Athir, *al-Kamil*, trans. Richards, 3:79, 158; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 156-57; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 153, 155-56; James of Vitry, *Historia orientalis*, ed. Donnadieu, p. 466, trans. Stewart p. 119 . Cf. Raphael, *Muslim Fortresses*, p. 17. For discussions of the castle, see Conder and Kitchener, *Survey of Western Palestine*, 1:390; Creswell, "Fortification in Islam," p. 123; Benvenisti, *The Crusaders*, pp. 358-62; Raphael, *Muslim Fortresses*, pp. 20-24.

[606] Oliver of Paderborn, *Historia Damiatina* 2-4, ed. Hoogeweg, pp. 163-68, trans. Gavigan, pp. 53-56; James of Vitry, *Lettres* no. 3, ed. Huygens, pp. 98-99; *Eracles* 31.10-12, RHC Oc 2, pp. 321-25; Ernoul, *Chronique* 35, ed. De Mas Latrie, pp. 411-12; *Cronica S Petri Erfordensis moderna*, ed. Holder-Egger, pp. 385-86; *Cronica Reinhardsbrunnensis*, ed. Holder-Egger, pp. 590-91; Ibn al-Athir, *al-Kamil*, trans. Richards, 3:174-75; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 160-63; Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 88; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 164-65; *History of the Patriarchs*, trans. Khater and Khs-Burmester, 3.2:212-13. See also Marshall, *Warfare in the Latin East*, pp. 226, 228; Raphael, *Muslim Fortresses*, p. 18. Cf. Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, p. 18.

[607] Ibn al-Athir, *al-Kamil*, trans. Richards, 3:175.

Damietta region: deployment of forces, 1218 (after Powell)



south. These similarities, and the significance of the 1218-19 siege, have allowed Christopher Marshall to judge this siege as one of two that best reveal the dynamics of major thirteenth-century Frankish-Muslim sieges.[608]

In March 1218, the group of crusaders who had attacked Mount Tabor was joined by additional crusaders from Frisia, Cologne and other parts of Germany. With support from the local baronage and the military orders, this force set out by sea from Acre for Egypt. Advance units captured the port area of Damietta on 29 May and established a camp on the west side of the Nile before King John of Brienne and other notables arrived a few days later.[609] Since Amalric's campaigns in Egypt a half-century earlier, Damietta's defences had been strengthened. In 1181 Saladin had overseen repairs to the two towers that commanded the chain across the river and had strengthened the town's walls. Despite this, al-Maqrizi claims that al-'Adil considered tearing down the pyramids to use their cut

[608] Marshall, *Warfare in the Latin East*, pp. 250-53.
[609] Oliver of Paderborn, *Historia Damiatina* 10, ed. Hoogeweg, pp. 175-78, trans. Gavigan, pp. 61-62. James of Vitry, *Lettres* nos. 3, 4, ed. Huygens, pp. 100, pp. 103-4. Cf. Ibn al-Athir, *al-Kamil*, trans. Richards, 3:176; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 30-31; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 153; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 166; *History of the Patriarchs*, trans. Khater and Khs-Burmester, 3.2:216.

stone to develop the city's fortifications in 1196.[610] By 1218, the city was secured by two lines of walls and the famous Tower of the Chain.[611]

The Franks had landed on the west side of the mouth of the Damietta branch of the Nile and made camp upstream across from the city. The crusaders erected artillery on their bank of the river to provide cover for marine assaults against the tower, which was finally taken on 25 August 1218. A pause then ensued as the Franks expected the arrival of additional forces and al-Kamil, who had positioned himself opposite the Franks on the east bank, awaited the arrival of his father, al-'Adil, who died travelling to support his son.[612]

To prevent the Franks from crossing the river, the Muslims had fortified the right bank south of Damietta. An earthen rampart was raised and ships and stakes were sunk in the river to further impede any attempt to cross it. The Frankish sources claim that these defences were also supported by artillery.[613] The Franks avoided these obstacles by developing the narrow al-Azraq channel, but they found the right bank undefended when they crossed on 5 February 1219; al-Kamil had fled in fear of a plot against him, leading his forces to abandon their camp the night before the crossing.[614] Despite this, al-Kamil retained control of his army and, joined by his brother al-Mu'azzam of Damascus, established a new base upstream at Mansura from which he repeatedly sent forces against the Franks.[615]

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[610] al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 122, 144-46. These fears were not entirely unfounded as the Nile delta had been raided by Frankish forces earlier in the thirteenth century, Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 153; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 146; *History of the Patriarchs*, trans. Khater and Khs-Burmester, 3.2:193-95.

[611] For contemporary accounts of this tower, see William of Tyre, *Chronicon* 20.15, ed. Huygens, 2:929, trans. Babcock and Krey, 2:363; Ibn al-Athir, *al-Kamil*, trans. Richards, 3:176; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 166. See also Powell, *Anatomy of a Crusade*, p. 141.

[612] Oliver of Paderborn, *Historia Damiatina* 11-14, 16, 18, 21, ed. Hoogeweg, pp. 179-91, 194-96 trans. Gavigan, pp. 63-72; James of Vitry, *Lettres* nos. 3, 4, 5, ed. Huygens, pp. 100, 105-8, 109, 114-16; Roger of Wendover, *Flores historiarum*, ed. Hewlett 2:229-34, trans. Giles 2:406-10; *Cronica S Petri Erfordensis moderna*, ed. Holder-Egger, pp. 386-87; *Cronica Reinhardsbrunnensis*, ed. Holder-Egger, p. 592; Ibn al-Athir, *al-Kamil*, trans. Richards, 3:176-77; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 167-68; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 166-67; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, p. 26; *History of the Patriarchs*, trans. Khater and Khs-Burmester, 3.2:215-19.

[613] Oliver of Paderborn, *Historia Damiatina* 22, ed. Hoogeweg, p. 196, trans. Gavigan, pp. 73-74; James of Vitry, *Lettres* no. 5, ed. Huygens, p. 114; Roger of Wendover, *Flores historiarum*, ed. Hewlett, 2:238-39, trans. Giles, 2:415. For these defences, see also Ibn al-Athir, *al-Kamil*, trans. Richards, 3:176-77; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 172.

[614] James of Vitry, *Lettres* no. 5, ed. Huygens, p. 118; Ernoul, *Chronique* 36, ed. De Mas Latrie, pp. 418-20; Ibn al-Athir, *al-Kamil*, trans. Richards, 3:177; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 173-74; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, p. 33.

[615] Oliver of Paderborn, *Historia Damiatina* 23, 25, 27, 29-31, ed. Hoogeweg, pp. 201-2, 205-7, 211-13, 213-24, trans. Gavigan, pp. 76, 78, 179-80, 81-84-86; James of Vitry, *Lettres* no. 5, ed. Huygens, pp. 118-19; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 174-75.

On the right bank, the Franks built artillery: *petrariae* and *trabucula*, according to James of Vitry, and *perrieres*, *mangoniaus* and *trebuces*, according to the Ernoul account,[616] while efforts were also made to blockade and mine the city. Despite the diminishing provisions within Damietta, the defenders were able to launch a successful sally and burn many of the Franks' engines at one point.[617] Even without their machines, the Franks pressed the attack with fire and ladders, gaining the outer defences of the city at the start of November. On 5 November 1219 the city surrendered.[618]

Artillery at Damietta

Artillery is noted at a number of points and is described as fulfilling different roles during this siege. It was used by Damietta's defenders in the summer of 1218 to protect the Tower of the Chain, damaging Frankish ships and ladders as they attacked it.[619] Oliver of Paderborn specifies that at least six *machine* [*sic*], mounted on towers, were used in this way but that the most powerful one broke after just a few shots.[620] These do not appear to have been particularly strong engines as netting hung in front of the ship-borne siege towers, which carried their own *lapidum iactatores*, was enough to resist the defenders' projectiles. These light engines were almost certainly traction trebuchets and probably distinct from certain heavier engines among those found by the Franks when they entered the city in November 1219: "four *trabucculi* with *petrariae* and many *mangonelli*."[621] Oliver of Paderborn states that eight *mangonelli* were directed against the crusaders' camp in 1219 but he does not quantify the *petrariae*.

[616] James of Vitry, *Lettres* no. 5, ed. Huygens, p. 119; Ernoul, *Chronique* 36, ed. De Mas Latrie, p. 424. *Petrariarum* and *trebuculorum*) according to Roger of Wendover, *Flores historiarum*, ed. Hewlett, 2:243, trans. Giles 2:418.
[617] Oliver of Paderborn, *Historia Damiatina* 28, ed. Hoogeweg, p. 211 trans. Gavigan, p. 80; *Cronica Reinhardsbrunnensis*, ed. Holder-Egger, p. 593.
[618] James of Vitry, *Lettres* no. 6, ed. Huygens, pp. 125-26; Oliver of Paderborn, *Historia Damiatina* 32, ed. Hoogeweg, pp. 224-25, trans. Gavigan, pp. 86-87; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 176-77; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, p. 31. Cf. Roger of Wendover, *Flores historiarum*, ed. Hewlett, 2:248, trans. Giles 2:423; Marino Sanudo, *Liber secretorum* 3.11.8, ed. Bongars, p. 208, trans. Lock, p. 331; Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 91; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 179. For complete accounts of this siege, see Oliver of Paderborn, *Historia Damiatina* 10-32, ed. Hoogeweg, pp. 175-226; James of Vitry, *Lettres* nos. 3-6, ed. Huygens, pp. 100, 103-10, 114-32; Ernoul, *Chronique* 36, ed. De Mas Latrie, pp. 415-26; *Eracles* 31.14-32.14, RHC Oc 2, pp. 326-46.
[619] Oliver of Paderborn, *Historia Damiatina* 11, ed. Hoogeweg, p. 181, trans. Gavigan, p. 64; James of Vitry, *Lettres* no. 4, ed. Huygens, pp. 105-6.
[620] Oliver of Paderborn, *Historia Damiatina* 13, ed. Hoogeweg, p. 183, trans. Gavigan, p. 66. See also Roger of Wendover, *Flores historiarum*, ed. Hewlett, 2:231-32, trans. Giles, 2:408-9.
[621] Oliver of Paderborn, *Historia Damiatina* 39, ed. Hoogeweg, p. 239, trans. Gavigan, p. 96.

Oliver of Paderborn's selective use of terminology suggests that he categorised the defenders' artillery. The new term, *trabucculi*,[622] most likely refers to counterweight trebuchets, used to target the Frankish engines and stationary targets, while the *petrariae* and *mangonelli*, probably traction trebuchets, were used against ships and personnel. It is hard to gauge the strength of the defenders' strongest engines as their artillery is rarely emphasised. Although stones are noted inflicting casualties and minor damage, it is unclear whether, or when, these were thrown mechanically or by hand. This lack of emphasis seems to indicate that these defensive engines were either fairly ineffective or not particularly powerful.

Oliver of Paderborn and James of Vitry claim that the Franks also made use of *trabuculi*, against the Tower of the Chain for example. This term was then widely adopted by subsequent chroniclers, although the traditional *mangoneaus* is found in the *Eracles* account in this instance:

Oliver of Paderborn	*Non vero considerantes, turrim capi non posse petrariarum vel trabuculorum ictibus (hoc enim multis diebus fuit attemptatem), nec applicatione castri propter fluminis profunditatem, neque fame propter civitatis vicinitatem, neque suffossione propter circumfluentis aque importunitatem,*[623]
James of Vitry	*Mansimus autem in insula predicta IIII mensibus detenti in expugnatione cuiusdam turris mire fortitudinis, que nec petrariis nec instrumentis que trabucula dicuntur poterat superari nec a parte inferiori suffodi eo, quod in medio Nili fluminis inter insulam et civitatem sita erat,*[624]
Roger of Wendover	*Principes interea militiae Crucifixi de captione turris nimis solliciti viderunt eam capi non posse fame, propter civitatis vicinitatem; neque suffossione, propter aquae circumfluentis importunitatem; neque insultu petrariarum aut trebuculorum ictibus, quia, cum id multis esset diebus attentatum, parum vel nihil profecerunt.*[625]
Cronica Reinhardsbrunnensis	*Cristiani vero considerantes turrim non posse capi petrariorum et tribuculorum ictibus neque fame propter vicinitatem civitatis,*[626]
Eracles	*Quant li Crestien si furent herbergé et atiré, si entendirent a faire assaillir la tor de la Cosbarie, si drecerent perrieres et mangoneaus et les firet geter a cele tor,*[627]

[622] For the appearance of this term, see Chapter 1.
[623] Oliver of Paderborn, *Historia Damiatina* 12, ed. Hoogeweg, p. 181.
[624] James of Vitry, *Lettres* no. 4, ed. Huygens, p. 105.
[625] Roger of Wendover, *Flores historiarum*, ed. Hewlett, 2:229.
[626] *Cronica Reinhardsbrunnensis*, ed. Holder-Egger, p. 592.
[627] *Eracles* 31.14, RHC Oc 2, p. 327. Cf. Ernoul, *Chronique* 36, ed. De Mas Latrie, p. 416.

While these descriptions present the Frankish artillery as insufficiently powerful to threaten the defensibility of the Tower of the Chain, these same engines would appear to be the 'machines' responsible for damaging the bridge that connected the tower to the city.[628] Like Oliver of Paderborn's classification of the defending artillery, James of Vitry also seems to present the *trabuculi* as the heaviest, likely counterweight engines, while the *petrariae* appear to have been lighter, noted as inflicting casualties when fired across the river.[629]

The heavier Frankish engines were apparently able to damage at least one of Damietta's twenty-eight outer towers in 1219. Oliver of Paderborn ascribes this to the *trabuccus* of the duke of Austria while Roger of Wendover credits the *trebuculus* of the Templars.[630] The *Eracles* account states that John of Bienne erected one *trabuchet*, the Hospitallers another and a third was held communally, while many *perrieres* and *mangoneaus* were placed around the city; but among these, it was the Hospitallers' *trabuchet* that inflicted notable damage.[631] These accounts again suggest that the heavier *trabuculi*, distinct from the lighter *petrariae* and *mangonelli*, were newer counterweight engines while the latter were probably traditional traction trebuchets or at most quite small counterweight engines. Despite the specificity shown by some sources, this was not embraced by all: the Ernoul account very generally groups the use of *perrieres*, *mangoniaus* and *trebucés* by the Franks during the 1219 phase of the siege.[632]

The significance but also the limitations of artillery are identified by the Frankish sources: although the heaviest trebuchets featured here appear to have been at least as powerful as any used in the region beforehand, none of the sources suggests that the damage inflicted by these engines led to the fall of the city.[633] Thus, while the heaviest machines were probably used to target the battlements first and then the bulk of the defences below the parapet, they were not yet powerful enough to compromise the

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[628] Oliver of Paderborn, *Historia Damiatina* 12, ed. Hoogeweg, pp. 182, trans. Gavigan, pp. 65.

[629] …*bellicis machinis, que petrarie dicuntur, lapides iaculando quosdam ex nostris interficientibus*, James of Vitry, *Lettres* no. 6, ed. Huygens, p. 130.

[630] Oliver of Paderborn, *Historia Damiatina* 38, ed. Hoogeweg, pp. 237-38, trans. Gavigan, p. 94; Roger of Wendover, *Flores historiarum*, ed. Hewlett, 2:250, trans. Giles, 2:424-25.

[631] *Eracles* 32.8, 14, RHC Oc 2, pp. 337-38, 345. Cf. *Chronica de Mailros*, ed. Stevenson, p. 136; Marino Sanudo, *Liber secretorum* 3.11.8, ed. Bongars, p. 208, trans. Lock, p. 331.

[632] Ernoul, *Chronique* 36, ed. De Mas Latrie, p. 421. Unlike his contemporaries, this figure appears to have had little interest in artillery, mentioning none during the attacks against the Tower of the Chain. For an examination of the Ernoul account and its relation with other accounts, see Edbury, "*Ernoul*, *Eracles* and the Fifth Crusade."

[633] Roger of Wendover states this outright, Roger of Wendover, *Flores historiarum*, ed. Hewlett, 2:243, trans. Giles, 2:418. See also Marshall, *Warfare in the Latin East*, pp. 226-29.

integrity of Damietta's defences, even after as long as seven months of bombardment in 1219. Meanwhile, traction trebuchets continued to provide an antipersonnel function. A Coptic source, however, has provided a different account.

According to the continuation of Sawirus ibn al-Muqaffa's chronicle, the Franks erected a large mangonel in their fortified camp on the west side of the river in 1218. This was destroyed by another engine erected by the defenders, leading the Franks to build an even larger mangonel as well as four others. The largest of these targeted the city while the smaller ones fired at the Tower of the Chain. The author gives a sense of the scale of the smaller engines when stating that these proved incapable of reaching the tower. Despite their apparent weakness, the author states that the Franks built two more mangonels and another 'stone-thrower'. It is unclear how the author differentiated a mangonel and a 'stone-thrower'; however, the latter would not appear to have been very large as a stone-thrower is said to have been mounted on the Tower of the Chain by the defenders. Although this account provides more mechanical details than others at times, its descriptions are often contradictory.

In a later anecdote, the smaller mangonels, which could not reach the Tower of the Chain, were used to throw the heads of dead Muslims into Damietta from across the river. Despite the apparent inconsistency, the author appears to portray these engines as fairly light compared to the larger mangonel built by the Franks. This engine is described as having a lead box, weighing 2 Syrian *qintars* (370 kg), at its 'head' and throwing projectiles weighing 1 Syrian *qintar* (185 kg).[634] The counterpoise suggests that this was a counterweight trebuchet but the disparity between the mass of the counterpoise and the mass of the projectiles is impractical.[635] The author seems to suggest that this was a particularly large engine, requiring six hundred men to operate. Even if the impractically large crew is set aside, and the unlikely size of the projectiles, for which there is no substantiating evidence, is accepted, it is hard to justify the use of such a small counterweight. The mechanics of a counterweight trebuchet generally require a counterweight that is at least ten times the mass of any intended projectile in order to fire with any kind of success, while a disparity of around 100 times will generally allow for a fairly efficient firing sequence and one of 1,000 times will produce a long-range shot.

[634] *History of the Patriarchs*, trans. Khater and Khs-Burmester, 3.2:215-21.

[635] Paul Chevedden has used this as part of a theory that this was a 'hybrid' engine, supported by a reference to 600 men who 'hauled' below the engine; however this does not take into account the impracticality of 600 men providing traction power simultaneously, Chevedden, "The Hybrid Trebuchet," pp. 186-87.

Taken as a whole, it is hard to determine which elements of this description can be trusted as each seems to contradict the practicality of another, apparently reflecting the author's ignorance of these engines and their mechanics.

The Push to Mansura: 1221

After fortifying Damietta, the Franks marched south towards Mansura, on the right bank of the Damietta branch just south of where the Ushmum canal (al-Bahr as-Saghir) diverts to the northeast towards Tanis.[636] The Franks arrived at the fork in the river before the end of July 1221 and established a camp enclosed by earthworks. According to Oliver of Paderborn and al-Maqrizi, they also erected artillery.[637] Together with the Muslim army's use of artillery to defend the right bank of the river south of Damietta, these appear to be the first examples of artillery being used against field forces during the crusades. Although plausible, such references should be regarded with caution, as unlike some classical engines, the more parabolic trajectory of swing-beam artillery and difficulties associated with yawing make this type of engine much better suited to siege warfare.[638] However, Oliver of Paderborn's use of differing terms, Muslim *mangonelli* south of Damietta and Frankish *petrariae* at Mansura, and al-Maqrizi's notice of artillery in both instances appear to lend credence to this episode.[639] If present, these engines do not appear to have influenced the situation. Syrian reinforcements continued to join al-Kamil as the Franks held their position, eventually compelling the Franks to burn their camp on the night of 26 August and flee towards Damietta, leading to their surrender and the return of Damietta in exchange for their lives.[640]

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[636] Oliver of Paderborn, *Historia Damiatina* 39, 40, ed. Hoogeweg, pp. 240-41, trans. Gavigan, pp. 96-97; James of Vitry, *Lettres* nos. 6, 7, ed. Huygens, pp. 128, 134-35, 139-40; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 179; Pringle, "A Castle in the Sand," p. 190.

[637] Oliver of Paderborn, *Historia Damiatina* 72, ed. Hoogeweg, p. 269, trans. Gavigan, p. 125; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 185. For the movement of the Franks, see Oliver of Paderborn, *Historia Damiatina* 57-59, ed. Hoogeweg, pp. 259-61, trans. Gavigan, pp. 114-16; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 31-32; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 179-80.

[638] Cf. Marino Sanudo, *Liber secretorum* 2.4.22, ed. Bongars, p. 79, trans. Lock, pp. 134-35.

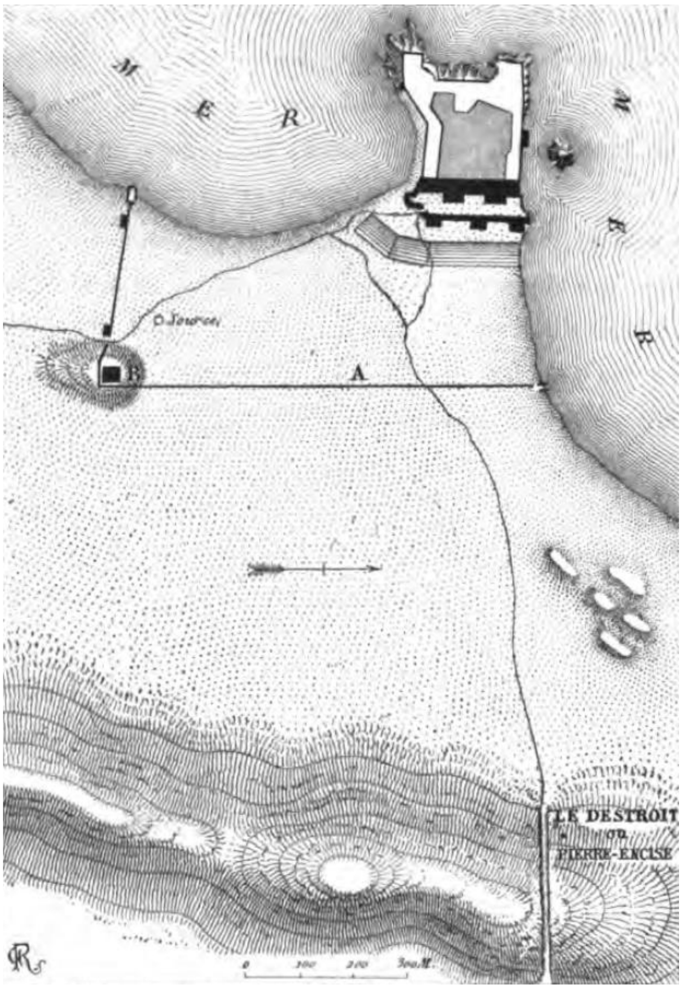
[639] Oliver of Paderborn, *Historia Damiatina* 30, 72, ed. Hoogeweg, pp. 219, 269, trans. Gavigan, pp. 84, 125; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 185.

[640] Oliver of Paderborn, *Historia Damiatina* 71, 74-78, ed. Hoogeweg, pp. 267-69, 270-75, trans. Gavigan, pp. 123-24, 126-31; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 33-34; Ibn al-Athir, *al-Kamil*, trans. Richards, 3:181; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 184; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 181, 184-87.

'Atlit and Caesarea: 1218-20

While considerable numbers of crusaders and eastern Franks were occupied with the siege of Damietta, forces from Damascus took the opportunity to strike at the newly constructed Templar castle at 'Atlit (Castellum Peregrinorum) and Caesarea.[641] According to James of Vitry and the *Eracles* account, Mu'azzam 'Isa besieged Caesarea and 'Atlit in 1218 before making for Egypt to support his brother.[642] While James of Vitry characterises the attack on Caesarea as more of a sack, the *Eracles* account states that three *perrieres* were used, implying an additional facet of complexity. Oliver of Paderborn, however, states that Mu'azzam 'Isa took Caesarea following his return from Egypt in 1219, destroying it before going on to besiege 'Atlit.[643] The similarities suggest that the sources are

'Atlit: town and castle, plan (from Rey)



[641] For the fortification of these sites, see Oliver of Paderborn, *Historia Damiatina* 5-6, 26, ed. Hoogeweg, pp. 168-72, 207-11, trans. Gavigan, pp. 56-58, 78-79; James of Vitry, *Lettres* no. 3, ed. Huygens, p. 99; Roger of Wendover, *Flores historiarum*, ed. Hewlett, 2:261, trans. Giles, 2:434; *Cronica S Petri Erfordensis moderna*, ed. Holder-Egger, p. 386. For descriptions and discussions of 'Atlit castle, see Oliver of Paderborn, *Historia Damiatina* 6, ed. Hoogeweg, pp. 169-72, 290-91, trans. Gavigan, pp. 57-58, and letter no. 3 (1218), ed. Hoogeweg, pp. 290-91; Conder and Kitchener, *Survey of Western Palestine*, 1:293-96; Rey, *Étude sur les monuments*, pp. 97-99; Deschamps, *Les Châteaux*, 2:24-34; Johns, *Guide to 'Atlit*, ed. Pringle; Johns, "Excavations, (1932)," pp. 145-64; Johns, "Excavations: Faubourg," pp. 111-29; Boase, "Military Architecture," pp. 157-58; Benvenisti, *The Crusaders*, p. 176-78; Pringle, "Town Defences," pp. 91-92; Kennedy, *Crusader Castles*, pp. 125-26; Boas, *Crusader Archaeology*, pp. 110-12. For the limited fortification of Caesarea see, Oliver of Paderborn, *Historia Damiatina* 5, ed. Hoogeweg, pp. 168-69, trans. Gavigan, p. 56. See also Wilbrand of Oldenburg, *Itinerarium terrae sanctae* 2.2, ed. Pringle, pp. 131-32, trans. Pringle, p. 86.

[642] James of Vitry, *Lettres* nos. 3, 4, ed. Huygens, pp. 101-2, 108; *Eracles* 32.5-6, RHC Oc 2, pp. 334-36 (lower text). Cf. Johns, *Guide to 'Atlit*, ed. Pringle, pp. 18, 20, and notes on pp. 1-2. Abu Shama notes a victory by Mu'azzam over the Templars at al-Kaimon at the end of August 1218 which may relate, Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 168, cf. p. 170.

[643] Oliver of Paderborn, *Historia Damiatina* 41, ed. Hoogeweg, pp. 244-45, trans. Gavigan, p. 99. See also Conder and Kitchener, *Survey of Western Palestine*, 1:299.

describing the same set of events, although the correct year is unclear as Mu'azzam 'Isa briefly returned to Egypt in 1219.[644]

Mu'azzam 'Isa returned to 'Atlit in October/November 1220. On this occasion, according to Oliver of Paderborn, he fortified his position and erected artillery:

> He set up one trebuchet, three petraries and four mangonels, and harassed the fortification night and day by blows of the machines. However, he could not move one stone from its place in the new towers and the middle wall. But the trebuchet of the [castle], with a petrary and a mangonel placed next to it, battered and broke the trebuchet and the petrary of the enemy.[645]

The mention of only one *trabuculum* on each side suggest that these were the most exceptional engines, probably counterweight trebuchets, but the differentiation between the *petrariae* and the *mangonelli* is once again more difficult to explain. The attacking engines appear to have had little impact on 'Atlit's thick but soft walls. Hugh Kennedy has concluded that the Ayyubid artillery was used against the castle's outer wall, unable to reach the inner line,[646] but the above account more accurately describes the inner defensive line with its two towers and connecting wall (*turribus novis ac muro medio*). This suggests that the castle's outer curtain may not have been built at this point or that Oliver of Paderborn, then in Egypt, was unaware of its completion. Nonetheless, the power of even the heaviest engines appears to be no more than those used at Damietta but the accuracy of those within, successfully destroying some of those opposing them, is noteworthy. Mu'azzam 'Isa made little headway against 'Atlit, its 300 crossbowmen and passive strength were sufficient to hold back the assailants until reinforcements began to arrive.[647] Unable to overwhelm the castle with a frontal assault, the Muslims cut their losses and withdrew before the end of November.[648]

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[644] For a secondary account of Mu'azzam 'Isa's movements, see Humphries, *From Saladin to the Mongols*, pp. 162.

[645] *Coradinus obsidione fimata metuens excursum castensium fossatum fieri iussit inter castrum et sua tentoria, erigens trabuculum unum, petrarias tres, mangonellos quatuor, diebus ac noctibus ictibus machinarum munitionem infestans, sed de turribus novis ac muro medio nec unum lapidem de suo loco movere valuit. Trabuculus autem castri cum petraria iuxta se posita ac mangonello trabuculum hostium et petrariam concutiens fregit.* Oliver of Paderborn, *Historia Damiatina* 52-53, ed. Hoogeweg, pp. 254-55, trans. Gavigan, pp. 108-9. The vagueness in Oliver of Paderborn's account is excusable given that he was in Egypt during these events. Cf. Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 94; Richard of Morins, *Annales Prioratus de Dunstaplia*, ed. Luard, p. 63.

[646] Kennedy, *Crusader Castles*, p. 127.

[647] Oliver of Paderborn, *Historia Damiatina* 53, ed. Hoogeweg, p. 256, trans. Gavigan, p. 110.

[648] Abu'l-Fida' claims that Mu'azzam 'Isa went on to besiege Caesarea after departing 'Atlit in 1220, adding to the confusion surrounding these campaigns in 1218-20, Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 94. Cf. Abu'l-Musaffar Sibt al-Djauzi, in Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 178.

The Sixth Crusade and War on Cyprus

With the concentration of Frankish forces in Egypt, Mu'azzam 'Isa had opted to slight many of the fortifications of interior Palestine, fearing this area and its strongholds would revert to Frankish control. This campaign of destruction extended to the walls of Jerusalem, though not the Temple Mount (Haram al-Sharif) and Tower of David, as well as Toron, Safed, Chastel Blanc (Safita), Mount Tabor, built by al-'Adil only a decade earlier,[649] and Belvoir.[650] While this would have consequences in the future, the Muslims turned their attentions away from the Franks as the threat posed by the armies of the Fifth Crusade dissipated.

Most sieges carried out during the 1220s and 1230s were conducted by Muslim armies against large urban centres throughout Syria. Unfortunately, detailed descriptions of artillery in sources that have been translated into European languages are scarce during this period: twenty non-descript engines appear to have been used by Jalal al-Din Khwarizim Shah at Khilat in 1229 and artillery seems to have been a notable weapon at al-Kamil's siege of Amida in 1232,[651] but little more is discernible. The continued Ayyubid conflict and arrival of Frederick II allowed the Franks to negotiate the return of Toron and Jerusalem, the latter still without walls, as well as the fortification of Jaffa and Sidon.[652] Frederick, however, was a divisive figure and the most informative Frankish sieges around 1230 were fought between his opponents and supporters.

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[649] Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 156-57; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 153, 156; James of Vitry, *Historia orientalis*, ed. Donnadieu, p. 466, trans. Stewart p. 119.

[650] Oliver of Paderborn, *Historia Damiatina* 24, 42, 52, ed. Hoogeweg, pp. 203, 245, 254, trans. Gavigan, pp. 76-77, 100-1, 108; *Eracles* 32.10, RHC Oc 2, pp. 339-40; Ernoul, *Chronique* 36, ed. De Mas Latrie, p. 417; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 141, 165-66, 173-74; Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 91; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 181. Belvoir appears have been slighted by Saladin in either 1191 or 1192 and remained abandoned until it was destroyed further at this point, Ambroise, *Estoire* ll. 6,835-69, ed. Paris, p. 183, trans. Ailes, pp. 124-25; *Itinerarium* 4.23, ed. Stubbs, p. 280, trans. Nicholson, p. 261; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 87-88.

[651] Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 2:394-95; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 44-47; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 211, 213-14, 216-18.

[652] Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 186; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 38-41; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 198-207. See also Bartlett, *Islam's War*, pp. 215-17. For the broader preoccupation of the Muslims, see also Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 190-91; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 42-43; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 210-11. For the fortification of Jaffa, see Philip of Novara, *Gestes des Chiprois* 157, ed. Raynaud, p. 77; *Annales de Terre Sainte*, ed. Rohricht and Raynaud, A and B p. 14 (438), ed. Edbury, pp. 152-53; Roger of Wendover, *Flores historiarum*, ed. 2:365-69, trans. Giles, 2:522-24. See also Pringle, "Town Defences," p. 94. For the fortification of Sidon, see *Eracles* 32.25, RHC Oc 2, p. 365; Marino Sanudo, *Liber secretorum* 3.11.10, ed. Bongars, p. 211, trans. Lock, p. 335; al-Maqrizi, *al-Suluk*, trans.

Kantara, Beirut and Kyrenia: 1229-33

During the siege of Kantara Castle in Cyprus in 1229-30, a *grant trabuc*, built by Anceau of Brie, was used by the Ibelins.[653] The topography of the site suggests that this engine would most likely have been erected on the plateau below the heavily fortified northeast front of the castle. This position is relatively close to the castle but significantly lower, limiting the amount of energy that a projectile could have communicated at the point of impact. Despite these difficulties, the engine itself was apparently so impressive that John of Beirut left the siege of Deidamour (St Hilarion) to view it.[654] More numerous engines were used soon afterwards at Beirut in 1231-32.

The town walls and citadel of Beirut had been rebuilt and refortified respectively by the time that Wilbrand of Oldenburg visited in 1211.[655] Wilbrand claims that the recently built towers had been reinforced with iron to resist the impact of heavy stones thrown by artillery, a measure that appears to have been tested two decades later. During this siege, which saw the use of many different siege engines, the *Eracles* account claims that the besieging artillery included a large *trabuchet*, capable of throwing stones weighing a *quintat*, three small *trabuches* and six *tunbereaus*.[656] Philip of Novara also uses three terms to identify the royal-Ibelin artillery at the siege of Kyrenia in 1232-33 (*perieres*, *mangueneaus* and *grans trabucs*), while the defenders, under Philip Chenart, are said to have employed *trabus*, *perieres*, and *mangueneaus*.[657]

At each of these sieges, Kantara, Beirut and Kyrenia, Philip of Novara asserts that the attacking artillery inflicted significant damage. He claims that a section of wall was brought down at Kantara, but the rocky approaches were steep enough to repel a frontal assault and hard enough to resist the Ibelin sappers. Although Philip gives no description of a *trabuc*, or *trabucher*,[658] these terms again appear to denote the most powerful type of

Broadhurst, pp. 204-5. See also Kalayan, "The Sea Castle of Sidon," pp. 81-82; Mesqui, "La fortification des Croisés," p. 11; Deschamps, *Les Châteaux*, 2:229-32.

653 Philip of Novara, *Gestes des Chiprois* 148, ed. Raynaud, p. 63, trans. La Monte, p. 105.

654 Philip of Novara, *Gestes des Chiprois* 148-51, ed. Raynaud, pp. 62-67, trans. La Monte, pp. 105-7. See also *Eracles* 33.11, RHC Oc 2, p. 377.

655 Wilbrand of Oldenburg, *Itinerarium terrae sanctae* 1.5, ed. Pringle, pp. 118-19, trans. Pringle, p. 65.

656 *Eracles* 33.22, RHC Oc 2, p. 388. See also Philip of Novara, *Gestes des Chiprois* 159, 162, 164, ed. Raynaud, pp. 78-79, 83, 86, trans. La Monte, pp. 120-21, 129, 133; For the broader siege, see Philip of Novara, *Gestes des Chiprois* 158-70, ed. Raynaud, pp. 76-89, trans. La Monte, pp. 118-37; *Eracles* 33.19-29, RHC Oc 2, pp. 385-96; *Annales de Terre Sainte*, ed. Rohricht and Raynaud, A and B p. 15 (439).

657 Philip of Novara, *Gestes des Chiprois* 198, 199, ed. Raynaud, pp. 108, 109, trans. La Monte, pp. 157, 158.

658 As it is alternatively labelled, Philip of Novara, *Gestes des Chiprois* 151, ed. Raynaud, p. 66, trans. La Monte, p. 108.

artillery. Like the *trabuculi*/*trabuches* at Damietta in 1219 and the *perieres*/*petrariae* at Acre in 1191, the use of only one such engine by an army, or contingent, in most cases suggests both the relative power and prowess of these engines relative to others. While these larger engines were almost certainly counterweight trebuchets, the greater numbers of smaller machines were probably traction trebuchets, employed in a similar capacity and numbers as they had been in the twelfth century. References to small *trabuches* by some sources may suggest the use of smaller counterweight trebuchets, which others may have continued to identify by using traditional terms. The *perieres* noted by Philip of Novara, distinct from the *trabucs* and *mangueneaus*, may have been counterweight trebuchets in the same way that the notable *perieres*/*petrariae* found at Acre in 1191 probably were.

Although counterweight trebuchets of differing sizes may have been built, the power of even the largest was still limited: Philip of Novara praises John of Caesarea's party of crossbowmen just as highly as his *grant trabuc* at Kantara.[659] Although the artillery used at Beirut is credited with inflicting notable damage, John of Ibelin's decision to abandon the siege when the defenders successfully countermined contextualises this: unlike mining, it was not yet a practical breaching weapon. Similarly, when the defenders thwarted the use of siege towers at Kyrenia, a year-long passive blockade ensued.[660] In this light it is clear that although heavy artillery was growing stronger it was still not powerful enough to be the focus of a siege strategy. Had it been more powerful at this point, it would be difficult to explain why it was not used after mining efforts failed at Beirut and the use of siege towers proved unsuccessful at Kyrenia.

[659] Philip of Novara, *Gestes des Chiprois* 152, ed. Raynaud, pp. 68-69, trans. La Monte, pp. 109-10.
[660] Philip of Novara, *Gestes des Chiprois* 198-201, ed. Raynaud, pp. 108-11, 116-17, trans. La Monte, pp. 157-61, 167-78.

Continued Infighting and the Earliest Physical Evidence

Jerusalem: 1239

In 1239, tensions between al-Salih Najm al-Din of Damascus and his brother al-'Adil II of Egypt came to a head and the Franks sustained a crushing defeat near Gaza.[661] Amid this confusion, al-Nasir Da'ud of Kerak took the opportunity to besiege Jerusalem towards the end of the year. Al-'Ayni states that al-Nasir directed artillery against the Tower of David and Ibn al-Furat, using Ibn Shaddad, appears to imply the same; however, al-Maqrizi gives the impression that a much more comprehensive attack took place, involving a three-week siege of the city.[662] If the Tower of David was targeted by the Muslims' artillery, no impact signatures can be identified along the contemporary sections of rusticated masonry, indicating the limited power of these engines.[663]

Beaufort: 1240

When al-Salih Najm overthrew his brother al-'Adil II in Egypt,[664] their uncle, al-Salih Isma'il, then of Damascus, appealed to the Franks. Among the territorial rights exchanged

[661] Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 60-62, 65-68; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 242-44, 245-49, 252-53. For the Frankish defeat, see Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 193; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 251; *Rothelin* 27-29, 35, RHC Oc 2, pp. 541-48, 555, trans. Shirley, pp. 47-51, 57-58; *Eracles* 33.44-45, RHC Oc 2, pp. 413-15, trans. Shirley, pp. 123-24; Matthew Paris, *Chronica maiora*, ed. Luard, p. 25, trans. Giles, 1:272-73; Marino Sanudo, *Liber secretorum* 3.11.15, ed. Bongars, p. 215, trans. Lock, p. 241.

[662] Al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 196; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:62; Al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 251. See also *Rothelin* 21, RHC Oc 2, pp. 529-30, trans. Shirley, p. 40. The *Rothelin* account states that the Franks had made improvements to the St Stephen (Damascus) gate before the siege, indicating that the town walls were not entirely indefensible since their destruction, but mentions only the citadel in the context of the siege proper, *Rothelin* 1, RHC Oc 2, p. 489, trans. Shirley, p. 13. For the Frankish fortification efforts during the 1230s, see also Pringle, "Town Defences," p. 80; Benvenisti, *The Crusaders*, p. 51.

[663] For descriptions of the Tower of David, see Fulcher of Chartres, *Historia Hierosolymitana* 1.26.4, ed. Hagenmeyer, pp. 284-85, trans. Ryan, p. 117; Wilbrand of Oldenburg, *Itinerarium terrae sanctae* 2.6, ed. Pringle, p. 133, trans. Pringle, p. 88; *Guidebook to Palestine*, trans. Bernard, p. 23. See also Boas, *Jerusalem*, pp. 66-75; Benvenisti, *The Crusaders*, p. 53. For archaeological investigations, see Johns, "The Citadel, Jerusalem," pp. 121-90; Solar, "Jerusalem, citadel moat," pp. 47-48. For a radical, if unlikely, theory of the citadel's development, see Ellenblum, "Frankish Castles," pp. 93-109. For Jerusalem's Ayyubid defences more broadly, see Hawari, *Ayyubid Jerusalem*, pp. 22-26; Boas, *Jerusalem*, pp. 44-49; Pringle, "Town Defences," pp. 79-80; Benvenisti, *The Crusaders*, pp. 50-51. For archaeological evidence of these early thirteenth-century defences, see Weksler-Bdolah, "The Fortification System," pp. 105-30; Reich and Shukron, "Excavation in the Mamillah Area," pp. 128-30, 145-50. See also Wilbrand of Oldenburg, *Itinerarium terrae sanctae* 2.6, ed. Pringle, p. 133, trans. Pringle, pp. 87-88; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 82-83; *Rothelin* 9, RHC Oc 2, p. 505, trans. Shirley, p. 22.

[664] Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 61-63; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 245, 254, 256-57.

for an alliance, al-Salih Isma'il agreed to return Safed and Beaufort;[665] the former had lain in ruins since the time of the Fifth Crusade while the latter had been developed by the Ayyubids.[666] Beaufort's defenders were less than willing to surrender their impressive castle, compelling al-Salih Isma'il to besiege the stronghold on behalf of the Franks. According to the *Rothelin* account, al-Salih Isma'il brought artillery from Damascus, which threw large and small stones against the castle.[667] Although there is no indication of how powerful these engines were, the account suggests not only that engines of two distinct scales were employed, but that both were stockpiled in Damascus. While the Ayyubids used artillery to assail each other into the 1240s, so too did the Franks.

Tyre: 1242

Balian of Beirut took advantage of the departure of Richard Filanghieri (the Emperor's marshal in the East) to attack Tyre in 1242. Philip of Novara's account states that after gaining the city, by a combination of surprise and collusion, the Ibelin party laid siege to the citadel with engines and *perieres*.[668] If Philip of Novara used a consistent set of terms to refer to specific types of artillery, these would appear to have been lighter than the heavier *trabucs* found elsewhere; however, the obscure medieval landscape of Tyre prevents any further analysis of how large these engines might have been.[669]

'Ajlun: 1243/44

Artillery appears to have been used when 'Ajlun was besieged on behalf of al-Salih Isma'il of Damascus. Ibn al-Furat gives no indication of how these mangonels were employed

[665] Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 193; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:6; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 68-69, 71, 73; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 261-63; *Eracles* 33.42-43, RHC Oc 2, pp. 417-18, trans. Shirley, pp. 125-26; *Rothelin* 32, RHC Oc 2, p. 552, trans. Shirley, pp. 55-56; *Annales de Terre Sainte*, ed. Rohricht and Raynaud, A and B p. 16 (440); Matthew Paris, *Chronica maiora*, ed. Luard, 4:64-65, 288-91, trans. Giles, 1:303, 482-84; Marino Sanudo, *Liber secretorum* 3.11.15, ed. Bongars, pp. 215-16, trans. Lock, pp. 341-42.

[666] For the Ayyubid contributions to the fortification of Beaufort, see Corvisier, "Les campagnes de construction," pp. 243-66; Deschamps, *Les Châteaux*, 2:197-208. See also Chapter 7.

[667] *Rothelin* 32, RHC Oc 2, pp. 552-53, trans. Shirley, pp. 55-56. Cf. Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:8.

[668] Philip of Novara, *Gestes des Chiprois* 227, ed. Raynaud, pp. 130-32, trans. La Monte, pp. 178-80. Engines are mentioned in the account of Marsiglio Georgio but are absent from most others, Marsiglio Georgio, part. trans. La Monte, in Philip of Novara, *The Wars of Frederick II*, p. 207. Cf. *Eracles* 33.52, 55, RHC Oc 2, pp. 422, 426-27, trans. Shirley, pp. 129, 131-32; Marino Sanudo, *Liber secretorum* 3.11.16, ed. Bongars, p. 216, trans. Lock, p. 343; Templar of Tyre, *Gestes des Chiprois* 242, ed. Minervini, p. 52, trans. Crawford, p. 17.

[669] No difficulties, such as those faced by the operators of the Jerusalem's northern defensive engines in 1099, are noted.

but, as at Jerusalem, no impact signatures are discernible on the surviving section of Ayyubid masonry. Once more this may suggest that the bossed masonry is obscuring the impact signatures of fairly light engines or that the targeted areas were among those subsequently damaged and rebuilt after one of the later earthquakes.[670]

The Consequences of La Forbie

The Khwarizmians do not appear to have used artillery when they sacked Jerusalem in 1244, following their alliance with al-Salih Najm Ayyub of Egypt against the Franks, al-Salih Isma'il of Damascus and al-Nasir Da'ud of Kerak.[671] Al-Salih Ismail's coalition was soundly defeated at the battle of La Forbie, outside Gaza on 17 October 1244,[672] allowing al-Salih Najm Ayyub to move first on Damascus and then on Homs. Al-Salih Najm's forces appear to have used artillery against the former,[673] but the disgruntled Khwarizmians do not appear to have used such engines when they besieged the city not long after.[674]

Ascalon: 1247

Work was underway to refortify Ascalon with a castle by 1240, coinciding with peaceful relations with Damascus and the crusade of Theobald IV of Champagne (king of

670 Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:1. Cf. al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 278. For studies of 'Ajlun see Johns, "Medieval 'Ajlun," pp. 21-33; Yovitchitch, "The Tower of Aybak," pp. 225-42; Yovitchitch, "Die Aiyubidische Burg 'Aglun," 118-25.

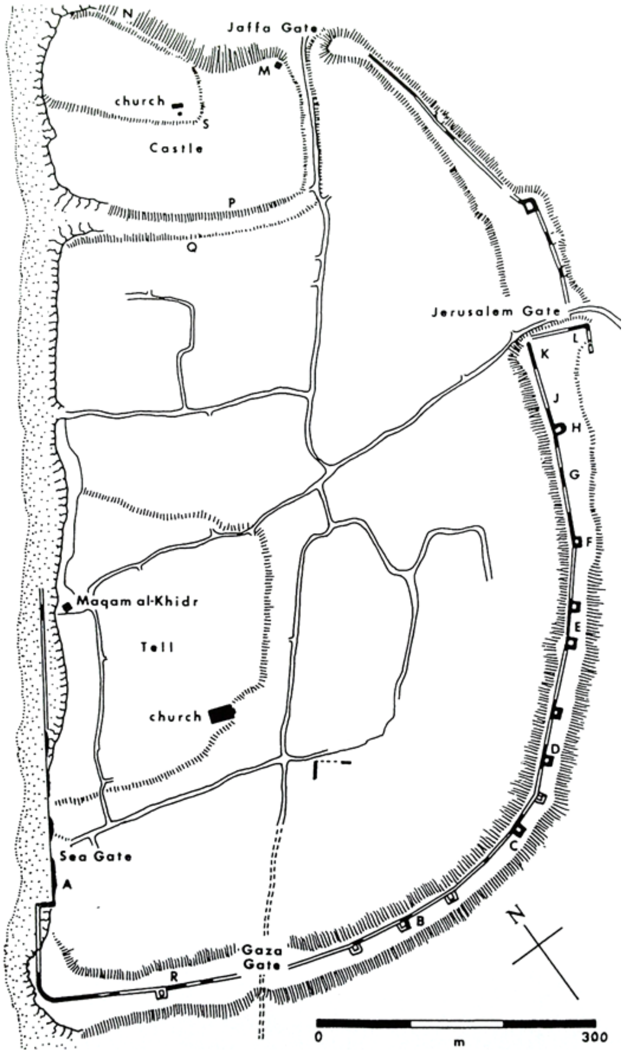
671 For this agreement, see Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:1-2; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 271-72. For the sack of Jerusalem, see *Rothelin* 41, RHC Oc 2, pp. 562-66, trans. Shirley, pp. 63-66; *Eracles* 33.56, RHC Oc 2, pp. 427-28, trans. Shirley, p. 132; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:2-3; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 75-76; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 273; Matthew Paris, *Chronica maiora*, ed. Luard, 4:288-91, 300-11, 337-44, trans. Giles, 1:482-84, 491-500, 522-28; *Annales de Terre Sainte*, ed. Rohricht and Raynaud, A and B p. 17 (441). The city remained defenceless at the time of Ibn Battuta's visit, Ibn Battuta, *Tuhfat* 1.1, trans. Gibb, p. 56.

672 *Eracles* 33.57, RHC Oc 2, pp. 429-31, trans. Shirley, pp. 133-34; *Rothelin* 41, RHC Oc 2, pp. 564-66, trans. Shirley, pp. 64-66; Templar of Tyre, *Gestes des Chiprois* 252, ed. Raynaud, pp. 145-46, trans. Crawford, pp. 19-20; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 193-94; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:4-7; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 76-77; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 274. See also John of Joinville, *Vie de Saint Louis* 528-38, ed. and trans. Monfrin, pp. 260-67.

673 Al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 275-77; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 77-78; *Eracles* 33.59, RHC Oc 2, p. 432, trans. Shirley, pp. 134-35; Chevedden, *The Citadel of Damascus*, pp. 73-74.

674 Al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 278-81; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 79-80; Chevedden, *The Citadel of Damascus*, pp. 74-75.

Ascalon: town and castle, plan (from Pringle)



Navarre).[675] The castle was completed by Richard of Cornwall, who saw to its initial security by concluding a truce with the Egyptians before returning to Europe.[676]

After the battle of La Forbie, the castle, which provided refuge for some Franks who escaped the battle, appears to have been besieged, although a more concerted effort to take the castle did not materialise until 1247.[677] That year, an Egyptian force crossed into Palestine, targeting Tiberias and Ascalon.[678] Tiberias, which had been recently refortified by Odo of Montbeliard, fell to a frontal assault but Ascalon posed a greater challenge and a fleet was summoned to complete a blockade. The defenders appealed to Henry of Cyprus and a naval standoff took place until a storm drove many of the Egyptian vessels onto some rocks. The *Eracles* account claims that this change in the weather came as a mixed

[675] *Rothelin* 22, 25, 33, RHC Oc 2, pp. 531-32, 537-38, 552, trans. Shirley, pp. 41-42, 45, 56. Cf. Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 71-72; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 263-64. See also *Eracles* 33.49, RHC Oc 2, pp. 419-20, trans. Shirley, pp. 126-27; *Rothelin* 34, RHC Oc 2, p. 554, trans. Shirley, p. 57; Matthew Paris, *Chronica maiora*, ed. Luard 4:79-80, trans. Giles, 1:315; Templar of Tyre, *Gestes des Chiprois* 254, Minervini, p. 58, trans. Crawford, p. 20; Marino Sanudo, *Liber secretorum* 3.11.15, ed. Bongars, p. 216, trans. Lock, p. 342; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 263-64, 267.

[676] Matthew Paris, *Chronica maiora*, ed. Luard, 4:43-47, 71, 89, 138-45, trans. Giles, 1:287-90, 308-9, 323, 362-68; *Rothelin* 36, RHC Oc 2, pp. 555-56, trans. Shirley, p. 59. For the development of Ascalon's fortifications, see Pringle, "Richard I," pp. 133-47.

[677] For the early siege efforts, see *Rothelin* 41, RHC Oc 2, p. 565, trans. Shirley, p. 65; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:8; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 274-75. See also Matthew Paris, *Chronica maiora*, ed. Luard, 4:559-60, trans. Giles, 2:174-75; Pringle, "The Walls of Ascalon."

[678] *Eracles* 33.59, RHC Oc 2, pp. 432-33, trans. Shirley, p. 135; Templar of Tyre, *Gestes des Chiprois* 258, ed. Minervini, p. 58, trans. Crawford, p. 21; *Annales de Terre Sainte*, ed. Rohricht and Raynaud, A and B p. 18 (442); Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 194; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2: 10-11; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, p. 82; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 283-84.

Ascalon: granite projectile (Denys Pringle)

blessing: the Muslims used the wreckage of their ships to construct penthouses and trebuchets.[679]

Artillery is not emphasised in the surviving accounts of this siege and the castle appears to have fallen after miners dug a tunnel into the castle.[680] However, this appears to be the first time that masts are recorded as being used to construct trebuchets in the East.[681] Whereas masts had been used at the sieges of Caesarea (1101),[682] Tyre (1111-12),[683] Ascalon (1153),[684] and Alexandria (1167)[685] to construct siege towers, the leftovers being allocated for the construction of artillery, their use to build artillery indicates both the increasing scale and significance of these engines. Although Muslim armies rarely built siege towers in this region, their part in the erection of one at Banyas in 1140 and Baybars' later construction of one at Caesarea in 1265[686] suggest that the use of siege towers remained a consideration throughout this period. It is revealing that artillery was considered to be the wisest use of this timber.

If masts were used to construct artillery, or even if this reference is more figurative than literal, it provides a rough sense of the scale of these engines. They would appear to have been larger than those used at the end of the twelfth century, a suggestion supported by the presence of spherical granite projectiles made from antique column-drums, albeit of unknown exact provenance. Two of these stones, found in the fosse near the Jaffa Gate, have a diameter greater than 30 cm. A number of smaller stones, which may have been

[679] *Eracles* 33.60-61, RHC Oc 2, pp. 433-35, trans. Shirley, pp. 135-36. See also *Annales de Terre Sainte*, ed. Rohricht and Raynaud, B p. 18 (442), ed. Edbury, p. 154.
[680] Cf. the Roman siege of Maogamalcha, Ammianus, *Res gestae* 24.4.2-23, ed. Eyssenhardt, pp. 303-7, trans. Yonge, pp. 357-61.
[681] *Eracles* 33.61, RHC Oc 2, p. 434, trans. Shirley, p. 136. James of Aragon states that sailors from Marseilles built a *trebuchet* from the masts and wood of a ship in 1229 during the conquest of Majorca, James of Aragon, *Llibre dels fets* 69, trans. Smith and Buffery, p. 93.
[682] Fulcher of Chartres, *Historia Hierosolymitana* 2.9.2, ed. Hagenmeyer, pp. 401-2, trans. Ryan, p. 153.
[683] Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 125-26.
[684] William of Tyre, *Chronicon* 17.24, ed. Huygens, 2:794, trans. Babcock and Krey, 2:222
[685] William of Tyre, *Chronicon* 19.28, ed. Huygens, 2:903-4, trans. Babcock and Krey, 2:337.
[686] Ibn 'Abd al-Zahir, *al-Rawd*, trans. Sadeque, 2:557; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:70-71; Thorau, *The Lion of Egypt*, pp. 160-61.

projectiles, have also been identified in the fosse that surrounded the thirteenth-century castle, strongly indicating that they date to the siege of 1247.[687]

It is hard to determine the effect that these projectiles had as the castle was destroyed following its capture and razed further by Baybars in 1270.[688] While there are suggestions that certain engines used at Ascalon were of an increasingly large scale, those used the following year at Homs were praised directly by the sources.

Homs: 1248-49

In 1248, al-Nasir Yusuf of Aleppo and al-Salih Isma'il moved against Homs. The city was surrendered before an Egyptian relief force arrived, compelling al-Salih Najm Ayyub to dispatch a larger force to retake it. According to Abu'l-Fida' and al-Maqrizi, fourteen mangonels were arrayed against Homs during this second siege. Like the engines brought against Beaufort four years earlier, these had been transported from Damascus, some in as many as fifty disassembled components. One of these engines, a *manjaniq maghribi*, was supposed to have been able to throw projectiles weighing 140 *ratls* of the Syrian measure (259 kg or 289 kg according to those of Damascus or Hama respectively),[689] around ten times the size of the stones found at Ascalon. This figure, drawn from Ibn Wasil, who was himself informed of these events by participants, is almost certainly an exaggeration; however, it can be seen to clearly distinguish this large engine from most of the other lighter ones. Hill and Chevedden are thus justified in believing that this was a counterweight trebuchet.[690] Although there is increasing evidence, both descriptive and physical, for the growing scale of artillery, these engines were still incapable of effectively breaching fortifications: the garrison of Homs held out through the winter until

[687] My thanks to Denys Pringle and Hannah Buckingham for bringing these stones to my attention. Although the granite stones have not been weighed, rough measurements of their circumference and an estimated density of 2,500 kg/m^3 suggest that the mass of the smaller stone is approximately 43 kg and the larger stone 60 kg.

[688] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:737, 741; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:140, 142; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:526; Ibn Battuta, *Tuhfat* 1.1, trans. Gibb, p. 57; Stager and Esse, "Ashkelon," p. 72. For archaeological examinations of this castle, see Pringle, "Town Defences," pp. 84-85; Pringle, "Richard I," esp. Appendix 1, pp. 144-46. Cf. Benvenisti, *The Crusaders*, pp. 120-28.

[689] Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 125; Al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 285-86. See also Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:11; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, p. 85.

[690] Hill, "Trebuchets," pp. 104, 106; Chevedden, *The Citadel of Damascus*, p. 280. My Thanks to Rabei Khamisy for translating the appropriate section of Ibn Wasil for me.

a peace was eventually brokered. The conclusion of this agreement was partly encouraged by news that Louis IX had arrived in the East.[691]

Louis IX and the Seventh Crusade

Louis IX of France left Cyprus and landed with a force of crusaders at the mouth of the Damietta branch of the Nile in the spring of 1249. Unlike the landings of the Fifth Crusade in 1218, the Sicilian force in 1184 and Frankish-Byzantine force in 1169, Louis' army encountered little opposition. After defeating an initial force that opposed their landing, the crusaders found Damietta and its provisions abandoned to them.[692] Al-Salih Najm Ayyub had returned to Egypt from Syria in expectation of the French king's arrival. Now sick, he established himself at Mansura, where his father, al-Kamil, had halted the southward advance of the Fifth Crusade.[693] Louis, like his predecessors twenty-eight years earlier, marched south to Mansura and dug in on the north bank of the Ushmum canal, opposite to his adversary, in December.[694]

The Franks erected two siege towers (*chas chastiaus*), used as elevated firing platforms, to provide cover for others constructing a causeway across the river.[695]

[691] Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, p. 83; Vincent of Beauvais, *Speculum historiale* 32.95, ed. Johann Mentelin, trans. in Jackson, *Seventh Crusade*, no. 72, pp. 121-22; John of Joinville, *Vie de Saint Louis* 144, ed. and trans. Monfrin, pp. 70-71.

[692] John of Joinville, *Vie de Saint Louis* 146-64, ed. and trans. Monfrin, pp. 72-81; *Rothelin* 59-60, RHC Oc 2, pp. 589-93, trans. Shirley, pp. 85-88; *Eracles* 34.1, RHC Oc 2, pp. 436-37, trans. Shirley, p. 137; Templar of Tyre, *Gestes des Chiprois* 263, ed. Minervini, p. 60, trans. Crawford, pp. 21-22; *Annales de Terre Sainte*, ed. Rohricht and Raynaud, A and B pp. 18-19 (442-43); Vincent of Beauvais, *Speculum historiale* 32.97-98, ed. Mentelin, trans. in Jackson, *Seventh Crusade*, no. 72, pp. 122-24; letter of Jean de Beaumont (1249), trans. in Jackson, *Seventh Crusade*, no. 58, pp. 85-86; letters of the Count of Artois, Guy (in service of the count of Melun), and William of Sonnac, in Matthew Paris, *Chronica maiora*, ed. Luard, 6:152-62, trans. Giles, 3:409-18; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 195; Ibn Wasil, *Mufarrij*, trans. Jackson, no. 73, pp. 130-31; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:15-16; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 288-90.

[693] Ibn Wasil, *Mufarrij*, trans. Jackson, no. 73, pp. 130-31; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:12, 17; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 83-84; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 287-88, 290-92.

[694] John of Joinville, *Vie de Saint Louis* 179-86, 191, 197, ed. and trans. Monfrin, pp. 88-91, 94-95, 96-97; *Rothelin* 62, RHC Oc 2, pp. 594-99, trans. Shirley, p. 89-92; *Eracles* 34.1, RHC Oc 2, p. 437, trans. Shirley, p. 137; Ibn Wasil, *Mufarrij*, trans. Jackson, no. 73, pp. 141-42; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:20; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 301.

[695] Cf. Amalric's attempt to bridge the Nile farther upstream, intending this bridge to be fortified with wooden towers provisioned with artillery, William of Tyre, *Chronicon* 19.22, 23, 29, ed. Huygens, 2:892-93, 895, 905, trans. Babcock and Krey, 2:325-26, 328, 339.

According to John of Joinville, sixteen Muslim *engins* targeted those working on the causeway. In response, the Franks constructed eighteen *engins* under Joscelin of Cornaut.[696] It is unclear how the Frankish and Muslim engines differed, but while Joinville claims that the Frankish artillery was incapable of inflicting any notable damage, that of the Muslims was not only capable of harrying work on the causeway but also supported Muslim forces who crossed the river and attacked the Frankish camp.[697]

Despite their effect against Frankish personnel, the Muslims' *engins* were not strong enough to threaten the siege towers. Against these, the Muslims erected, in Joinville's terms, a *perriere*.[698] This was probably a counterweight trebuchet, while the *engins* used by both the Franks and Muslims were traction trebuchets, elsewhere differentiated from large tension weapons (*arbalestre a tour*).[699] Despite the evidence that sizeable stones were thrown by Egyptian artillery at Ascalon and Homs, Joinville clearly communicates that the *perriere* threw incendiaries (containers of Greek fire) rather than stones at the Frankish towers.[700] Only the lighter *engins* appear to have thrown stones.[701]

The first shot discharged by the *perriere* passed between the two towers. The Franks who attempted to extinguish the subsequent fire were initially sheltered by wings extending from the bases of the towers; however, the Muslims adjusted their *engins*, firing high into the air to subject the Franks to plunging fire.[702] The apparently rapid rate of fire of these engines, targeting soldiers and workers, is another indicator that these were traction trebuchets, whereas the *perriere* discharged only three shots during the first night that it came into service. The Muslims appear to have slowly adjusted the range of the *perriere*, the first shot falling behind the Frankish towers before another fell short.[703]

Intriguingly, Joinville claims that the Muslims' *perriere* was used only at night; it was thus exceptional when it was brought forward one day.[704] Supported by a hail of stones thrown by the lighter *engins*, the *perriere* was advanced close to the river, the implicit suggestion being that this move contributed to the machine's ability to set both

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[696] John of Joinville, *Vie de Saint Louis* 192-95, ed. and trans. Monfrin, pp. 94-97.
[697] John of Joinville, *Vie de Saint Louis* 200-1, ed. and trans. Monfrin, pp. 98-99.
[698] John of Joinville, *Vie de Saint Louis* 203-4, ed. and trans. Monfrin, pp. 100-1.
[699] John of Joinville, *Vie de Saint Louis* 206, ed. and trans. Monfrin, pp. 100-1.
[700] This is similar to the use of such by the defenders of Acre in May 1190, 'Imad al-Din, *al-Fath*, trans. Massé, pp. 217-19; Baha' al-Din, *al-Nawadir*, trans. Richards, pp. 110-11; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:373-74.
[701] John of Joinville, *Vie de Saint Louis* 210, ed. and trans. Monfrin, pp. 102-3.
[702] John of Joinville, *Vie de Saint Louis* 205, ed. and trans. Monfrin, pp. 100-1.
[703] John of Joinville, *Vie de Saint Louis* 208, ed. and trans. Monfrin, pp. 102-3.
[704] John of Joinville, *Vie de Saint Louis* 209, ed. and trans. Monfrin, pp. 102-3.

towers on fire that day.[705] With the towers destroyed, Louis used timber from his barons' ships to build a new penthouse to extend the causeway. But after the men around the penthouse had been driven away by the sixteen *engins*, this too was set alight by the *perriere*.[706]

Joinville's clear distinction between the Muslim's antipersonnel stone-throwing *engins* and the single machine-targeting Greek fire-throwing *perriere* must be evaluated alongside other accounts. The *Rothelin* account states, rather non-specifically, that Louis employed *perrierez, mangongiax, trebuchez* and other *enginz* while the Muslims made use of *anginz*, which fired large and small stones as well as Greek fire and javelins.[707] In a letter composed by a Templar (or possibly a Hospitaller), the Muslims are noted as using many *machinae* and *fundibula* against the Franks and their efforts to cross the river.[708] Similarly, in a letter sent back to France in 1250, Louis IX mentions the use of *machinae* by both the Franks and Muslims. Although he does not provide detailed descriptions of these engines, Louis claims that the Muslims' artillery threw stones that damaged the Frankish towers, but confirms Joinville's assertions that it was Greek fire that ultimately destroyed them.[709] Florence of Worcester simply refers to Louis' use of *machinae* to facilitate his efforts to cross the river.[710] From the Muslim perspective, Ibn Wasil, Ibn al-Furat, al-'Ayni and al-Maqrizi confirm that the Franks fortified their position and used artillery (mangonels), but omit any mention of siege towers, penthouses or Muslim artillery.[711] Thus, while some sources appear to support certain aspects of Joinville's account, none fully corroborates it.

The crusaders abandoned their causeway following the destruction of the penthouse and eventually found a ford across the river in early February 1250. Louis then encamped part of his army on the south side of the river where the Muslims had been encamped in 1249, close enough to the river to be supported by the duke of Burgundy

[705] John of Joinville, *Vie de Saint Louis* 210, ed. and trans. Monfrin, pp. 102-3.
[706] John of Joinville, *Vie de Saint Louis* 211-13, ed. and trans. Monfrin, pp. 102-5.
[707] *Rothelin* 63, RHC Oc 2, p. 600, trans. Shirley, p. 93. Cf. Florence of Worcester, *Chronicon ex chronicis*, ed. Thorpe, 2:181.
[708] Matthew Paris, *Chronica maiora*, ed. Luard, 6:191-97.
[709] Letter of Louis IX to his subjects in France (1250), ed. Duchesne, in *Historiae Francorum Scriptores*, vol. 5, pp. 428-32, trans. in Jackson, *Seventh Crusade*, no. 70, pp. 108-14. See also Vincent of Beauvais, *Speculum historiale* 32.99, ed. Mentelin.
[710] Florence of Worcester, *Chronicon ex chronicis*, ed. Thorpe, 2:181-82, trans. Forester, p. 325.
[711] Ibn Wasil, *Mufarrij*, trans. Jackson, no. 73, pp. 141-42; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:20; al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 208; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 301.

from the crusaders' original camp.[712] The Muslims had apparently abandoned their artillery, fourteen *engins* according to the *Rothelin* account. These were evidently of little value to the crusaders as they were broken up to build a palisade around the new camp while a bridge was built across the river to connect the two Frankish camps.[713] Louis was initially able to defend this double-ended bridgehead but momentum was lost with the arrival of al-Mu'azzam Turanshah.[714] The Franks attempted to withdraw back across the Ushmum canal in early April and then made a disastrous effort to retreat back to Damietta, in which most of the army appears to have been captured or killed.

In his account of the negotiations between the Franks and Muslims that followed Louis' initial withdrawal across the river, Joinville gives the impression that the king was attempting to move with his artillery. During one of these dialogues, he claims that as a condition of Damietta being exchanged for Jerusalem, al-Mu'azzam Turanshah would mind the king's siege engines until he was able to collect them.[715] These talks broke down when Louis would not personally serve as a guarantor and the Franks' disastrous flight towards Damietta ensued.[716] Al-Mu'azzam Turanshah was murdered before Damietta was surrendered in early May 1250; having spent most of his adult life in Hisn Kayfa, he was never given the opportunity to employ artillery in the Levant.[717] Following Damietta's

[712] John of Joinville, *Vie de Saint Louis* 215-48, ed. and trans. Monfrin, pp. 104-23; *Rothelin* 64, RHC Oc 2, pp. 602-9, trans. Shirley, pp. 94-98; *Eracles* 34.1, RHC Oc 2, pp. 437-38, trans. Shirley, p. 138; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, p. 86; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 302-3.

[713] John of Joinville, *Vie de Saint Louis* 244, 254-61, 263-66 269-70, ed. and trans. Monfrin, pp. 120-21, 126-29, 130-33, 132-35; *Rothelin* 64, RHC Oc 2, pp. 607-8; trans. Shirley, p. 98; letter of Louis IX to his subjects in France (1250), ed. Duchesne, in *Historiae Francorum Scriptores*, vol. 5, pp. 428-32, trans. in Jackson, *Seventh Crusade*, no. 70, pp. 108-14; Marino Sanudo, *Liber secretorum* 3.12.2, ed. Bongars, p. 219, trans. Lock, p. 347. Cf. al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 303.

[714] For the death of al-Salih Najm Ayyub and arrival of Mu'azzam Turanshah in Egypt, see Ibn Wasil, *Mufarrij*, trans. Jackson, no. 73, pp. 133-43, 145-46; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 195-96; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 84, 86-87; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:23-26; Sibt Ibn al-Jawzi, trans. in Jackson, *Seventh Crusade*, no. 74a, p. 155; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 292-94, 306; John of Joinville, *Vie de Saint Louis* 196-97, 287-88, ed. and trans. Monfrin, pp. 96-97, 142-43. See also Thorau, *The Lion of Egypt*, pp. 32-36; Bartlett, *Islam's War*, pp. 227-30.

[715] John of Joinville, *Vie de Saint Louis* 301-3, ed. and trans. Monfrin, pp. 148-51. Cf. Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:28; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 307.

[716] John of Joinville, *Vie de Saint Louis* 304-25, ed. and trans. Monfrin, pp. 150-61; *Rothelin* 66, RHC Oc 2, pp. 612-16, trans. Shirley, pp. 100-3; *Eracles* 34.1, RHC Oc 2, p. 438, trans. Shirley, p. 138; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 87-88; Ibn Wasil, *Mufarrij*, trans. Jackson, no. 73, p. 147-8; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:28; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 307-8.

[717] For the murder of al-Mu'azzam Turanshah, see John of Joinville, *Vie de Saint Louis* 344-53, ed. and trans. Monfrin, pp. 168-75; Ibn Wasil, *Mufarrij*, trans. Jackson, no. 73, pp. 150-52; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, pp. 198-200; Rashid al-Din, *Ta'rikh-i Ghazani*, trans. Boyle, p. 234; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:33-34; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, p. 88; al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 311-13. See also Bartlett, *Islam's War*, pp. 230-31. For the surrender of Damietta, see *Rothelin* 69, RHC Oc 2, p. 623, trans. Shirley, p. 108; Ibn Wasil, *Mufarrij*, trans. Jackson, no. 73, p. 154; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:35-36. For the subsequent role of

return to the Muslims, it was deemed too vulnerable to defend and its fortifications were torn down. It was replaced as a port by al-Munshiya farther up river.[718]

The Aftermath

Following the collapse of the Seventh Crusade, the Ayyubid princes quickly turned their attention back to each other. In an effort to leave a positive legacy, Louis IX financed a major wave of fortification efforts along the Palestinian coast. The town walls of Caesarea,[719] Jaffa,[720] Acre[721] and Sidon[722] were all developed as well as certain citadels and urban castles. There can be little doubt that artillery was taken into consideration when these fortifications were constructed. Louis and his deputies would have been familiar with the capabilities of European artillery and had just experienced Ayyubid artillery at first-hand. An anecdote recounted by Joinville about the Count of Eu and his small model of a stone-thrower (*bible*), which fired pebbles into Joinville's tent and broke his glasses and pots, is an example of the close familiarity that the knightly class had with this kind of technology.[723] These were the men who commissioned, if not designed on

the party of murderous mamluks in Palestine during the 1250s, see Ibn 'Abd al-Zahir, *al-Rawd*, trans. Sadeque, pp. 80-93; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 89-97.

[718] Matthew Paris, *Chronica maiora*, ed. Luard 5:258, trans. Giles, 2:458; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:38. The city was still indefensible when Ibn Battuta visited in 1326, Ibn Battuta, *Tuhfat* 1.1, trans. Gibb, pp. 46, 49.

[719] John of Joinville, *Vie de Saint Louis* 470, 493,ed. and trans. Monfrin, pp. 232-33, 252-45; letter of the patriarch of Jerusalem to Blanche of Castile, queen of France (1251), in *Annales de Burton*, ed. Luard, p. 296, trans. in Jackson, *Seventh Crusade*, no. 115, p. 209; *Eracles* 34.2, RHC Oc 2, p. 440, trans. Shirley, p. 139; *Annales de Terre Sainte*, ed. Rohricht and Raynaud, A and B p. 21 (445), ed. Edbury, p. 155. For modern studies of Caesarea's defences, see Faucher. Merlin and Mesqui, "Césarée (Israël)," pp. 1-4; Mesqui, "L'enceinte médiévale de Césarée," pp. 83-94; Pringle, "Town Defences," pp. 89-91; Benvenisti, *The Crusaders*, pp. 138, 131-44; Frova, "Caesarea," pp. 150-51; Negev, "Caesarea," (1961), pp. 81-83; Negev, "Caesarea," (1960), pp. 264-65; Conder and Kitchener, *Survey of Western Palestine*, 2:13-28; Rey, *Étude sur les monuments*, pp. 221-25.

[720] John of Joinville, *Vie de Saint Louis* 515-17, 561-62, ed. and trans. Monfrin, pp. 254-57, 278-79; *Eracles* 34.2, RHC Oc 2, p. 440, trans. Shirley, p. 139; *Annales de Terre Sainte*, ed. Rohricht and Raynaud, A and B p. 21 (445), ed. Edbury, p. 155; Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:641; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:504-5; al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 227. For a more comprehensive history of Jaffa's defences, see Pringle, "Town Defences," p. 94.

[721] John of Joinville, *Vie de Saint Louis* 615-16, ed. and trans. Monfrin, pp. 304-5; *Eracles* 34.1, RHC Oc 2, p. 438, trans. Shirley, p. 138.

[722] John of Joinville, *Vie de Saint Louis* 582, ed. and trans. Monfrin, pp. 288-89. For modern studies of the fortifications of Sidon, see Mesqui, "La fortification des Croisés," pp. 11, 24-26; Pringle, "Town Defences," pp. 81-90; Boase, "Military Architecture," p. 161; Kalayan, "The Sea Castle of Sidon," pp. 81-83; Deschamps, *Les Châteaux*, 2:227-33; Pringle, "A Castle in the Sand," p. 188. For the Muslim attack during construction, see John of Joinville, *Vie de Saint Louis* 551-53, ed. and trans. Monfrin pp. 272-75; *Eracles* 34.2, RHC Oc 2, pp. 440-41, trans. Shirley, p. 139; Marino Sanudo, *Liber secretorum* 3.12.4, ed. Bongars, p. 220, trans. Lock, pp. 348-49. Cf. the siege in 1249, Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:18; al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 292.

[723] John of Joinville, *Vie de Saint Louis* 583, ed. and trans. Monfrin, pp. 288-91. For variants of this term, see Chapter 1.

occasions, both the engines and the fortifications that they would play against. Similarly, when such engines were not built at certain sieges, such as those of Mount Tabor in 1217 and Subayba in 1253, the reason cannot have been ignorance.[724]

The Mongols and the War of St Sabas

Mongols

When Louis IX left the Holy Land in late April 1254,[725] the East that he was leaving was in transition. The Mongols' westward migration continued and on 17 January 1258 Mongol forces under Hulagu crushed the army of Baghdad and entered the city less than a month later.[726] The Mongols would have learned about swing-beam artillery during the course of their campaigns in China, had they not known about it beforehand. According to Bar Hebraeus, a large body of Chinese men, "skilled in the working of engines of war and throwing naphtha", was sent west with Hulagu in 1252[727] and al-Makin Ibn al-'Amid's first reference to the use of artillery, in proximity to the Latin East, is at the Mongol siege of Irbil in 1258-59.[728] It has been suggested that the Mongols learned about heavier (counterweight) artillery from the Muslims. During the protracted siege of Fancheng (Xiangyang) from 1268 to 1273, Rashid al-Din notes that no 'Frankish mangonels' had formerly been employed in this region along the Chinese frontier, but that an artillery-

[724] John of Joinville, *Vie de Saint Louis* 563-81, ed. and trans. Monfrin, pp. 278-89. For the castle of Subayba, see Rey, *Étude sur les monuments*, p. 4; Conder and Kitchener, *Survey of Western Palestine*, 1:126; Deschamps, *Les Châteaux*, 2:145-74; Benvenisti, *The Crusaders*, pp. 147-57; Ellenblum, "Who Built Qa'at Subayba?" pp. 103-12; Amitai, "Notes on the Ayyubid Inscriptions at Subayba," pp. 113-119. Cf. Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:47; Ibn Jubayr, *Rihla*, trans. Broadhurst, p. 315. For the most recent archaeological work, see Hartal, *The al-Subayba (Nimrod) Fortress*.

[725] John of Joinville, *Vie de Saint Louis* 584-87, 603, 615-17, ed. and trans. Monfrin, pp. 290-93, 298-301, 304-7; *Eracles* 34.2, RHC Oc 2, p. 441, trans. Shirley, p. 441; *Annales de Terre Sainte*, ed. Edbury, pp. 155-56.

[726] For the Mongol migration in relation to Ayyubid matters, see Thorau, *The Lion of Egypt*, pp. 59-62; Bartlett, *Islam's War*, pp. 233-35.

[727] Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 2:419.

[728] Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 103-4. Cf. Rashid al-Din, *Ta'rikh-i Ghazani*, trans. Boyle, p. 190. See also the account of a Mongol siege by papal emissary Plano Carpini, in Raphael, *Muslim Fortresses*, p. 54.

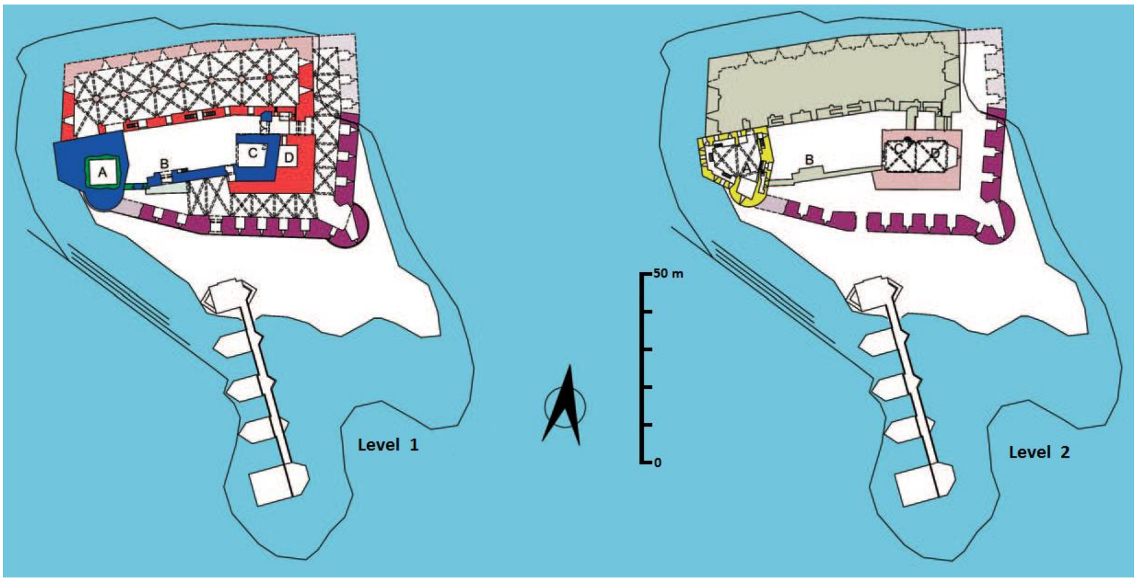
maker, who had come from Baalbek and Damascus with his three sons, constructed seven large mangonels that were used against the strongly fortified town.[729]

Whether the Mongols had prior knowledge of the heaviest artillery used in western Syria or not, their allies Hethum of Armenia, Bohemond VI of Antioch and al-Ashraf Musa of Homs, all present when Hulagu entered Aleppo on 25 January 1260,[730] certainly would have.[731] But there are few indications that the Mongols employed artillery during their conquest of western Syria: few strongholds resisted them and those that did, such as Subayba, typically fell to a frontal assault. The leading citizens of Damascus fled the city and it was occupied without opposition,[732] but a revolt by the garrison commander, following Hulagu's departure to the East, may have provided the opportunity for both sides to deploy their artillery.

Paul Chevedden has suggested that artillery was responsible for compelling the garrison of Damascus to surrender. Having spent the night of 25 April 1260 cutting wood for their artillery, the Mongols gathered ammunition the following day and moved more than twenty trebuchets into position to the west of Damascus on the night of 26 April. The bombardment that followed, according to Chevedden, led the garrison to seek terms after about twenty-four hours.[733] Although the technology would have been known and suitable materials could have been harvested along the banks of the Barada River, there would not appear to have been enough time to inflict the supposed damage. Besides the lack of any evidence to support the existence of artillery powerful enough to compel this type of reaction, the amount of time required to erect the Mongol engines was similar to that required by Saladin's forces seventy years earlier, suggesting they may not have been much larger.[734] The rebuilding work along the western side of the citadel is probably

[729] Rashid al-Din, *Ta'rikh-i Ghazani*, trans. Boyle, p. 290-91. See also Hill, "Trebuchets," p. 104; Chevedden, "Black Camels," p. 236 n. 17; Chevedden, "King James I," p. 318; Needham and Yates, *Science and Civilization in China*, p. 221.
[730] The citadel held out until 25 February. Thorau, *The Lion of Egypt*, pp. 66-67. See also Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 2:435-36.
[731] Hethum of Armenia had solicited the support of the Mongols in the 1250s and recognised their hegemony, his son-in-law-Bohemond initially rebuked the Mongols in 1244 but subsequently submitted to their rule, *Eracles* 34.2, RHC Oc 2, pp. 440, 442, trans. Shirley, pp. 139, 140; Vahram, *Chronicle*, trans. Neumann, pp. 48-49; Templar of Tyre, *Gestes des Chiprois* 302, trans. Crawford, p. 34; Matthew Paris, *Chronica maiora*, ed. Luard, 4:389-90, trans. Giles, 2:31; *Chronicle of Melrose*, ed. Stevenson, p. 158, trans. Stevenson, p. 188.
[732] Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:41-42; *Menkonis Chronicon*, ed. Weiland, pp. 547-49, trans. Barber and Bates, in *Letters from the East*, pp. 153-56; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, pp. 114-16.
[733] Chevedden, *The Citadel of Damascus*, pp. 78-79.
[734] See, for example, the sieges of Saone (1188), Safed (1188) and Jaffa (1192) discussed in Chapter 5.

Sidon: sea castle, plan (after Mesqui and Kalayan)



associated with a later destruction phase. This face of the citadel, along with the northern face, are part of the city's external walls and were most heavily slighted by the Mongols in 1260. They were then besieged repeatedly through the late medieval and modern periods.[735] Contrary to Chevedden's theory that the citadel's large towers, built by al-'Adil, were meant to be platforms for counterweight trebuchets, defensive artillery does not appear to have played a significant role in this siege.[736]

The Franks managed to evade the Mongols' gaze during the latter's campaign through Syria in 1259-60. Unlike Bohemond, the Franks of Palestine rejected any notion of Mongol suzerainty.[737] Sidon was the only Frankish possession to be attacked, in response to a raid into the Biqa' valley by Julian of Sidon from Beaufort. The Mongols do not appear to have employed artillery on this occasion, breaking into Sidon following a frontal assault but being unable to take either of the castles.[738] Although Sidon remained in Frankish hands, the attack was damaging enough to compel Julian to sell Sidon and Beaufort to the Templars.

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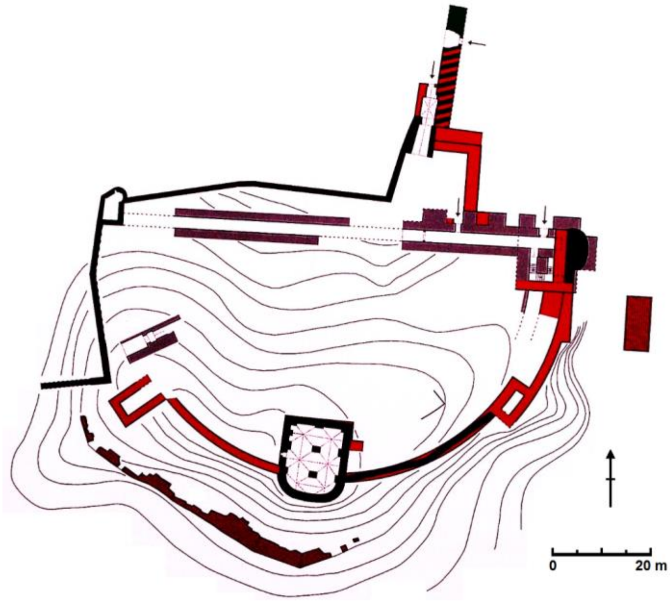
[735] For Chevedden's discussion of this slighting, derived largely from Ibn Shaddad, see Chevedden, *The Citadel of Damascus*, pp. 87-89.
[736] For more on this, see Chapter 10.
[737] *Rothelin* 80, RHC Oc 2, pp. 635-36, trans. Shirley, pp. 118-19; Ibn al-'Amid, *al-Majmu*, trans. Eddé and Micheau, p. 116. For interpretations of the Mongol invasion of Syria-Palestine in 1260, see Jackson, "Crisis in the Holy Land in 1260," pp. 481-513. For the brief Mongol administration of Syria see Amitai, "Mongol Provincial Administration," pp. 117-43.
[738] *Eracles* 34.3, RHC Oc 2, pp. 444-45, trans. Shirley, pp. 141-42; *Annales de Terre Sainte*, ed. Rohricht and Raynaud, B p. 25 (449); Marino Sanudo, *Liber secretorum* 3.12.6, ed. Bongars, p. 221, trans. Lock, p. 350; *Menkonis Chronicon*, ed. Weiland, p. 549; Hayton, *La flor des estoires* 3.24, RHC Ar 2, p. 174; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 203.

Sidon: land castle, plan (after Piana and Deschamps)



In Acre, preparations were made for a similar encounter: trees around the city were cut, towers beyond the city walls and the Church of St Nicholas were disassembled, and tomb stones were even removed.[739] These measures to deny materials for a siege camp or artillery, however, proved unnecessary. But it was not only Ayyubid and Mongol artillery that various Frankish factions in Acre had to contend with around this time. The wave of disruption that accompanied the Mongol invasion of Syria effectively ended the period of Ayyubid rivalry but the Franks remained relatively divided.

The War of St Sabas

Around thirty days of open fighting took place between Pisan and Genoese forces in Acre in 1249. According to the *Eracles* account, "they shot at each other with twenty-two different engines, stone-throwers, trebuchets and mangonels" while the *Annales de Terre Sainte* similarly states that twenty-two engines were used, including both large and small stone-throwers.[740] The Templar of Tyre, who also notes the use of large and small engines, states that "there was one such engine which hurled a stone so large that it weighed 100 *rotas*, and each engine had its own name."[741] While the former accounts emphasise the number of engines, the latter appears to give some indication of the size of the large trebuchets. Crawford suggests that the *rota* might be associated with the Cypriot *oka*, implying the mass of these projectiles was around 130 kg.[742] The *ratl* might also be

[739] *Annales de Terre Sainte*, ed. Rohricht and Raynaud, p. 449, ed. Edbury, p. 157; Marino Sanudo, *Liber secretorum* 3.12.6, ed. Bongars, p. 221, trans. Lock, p. 350.
[740] *...geterent les uns as autres de xxii manieres d'engins, perrieres, trebuches et mangouniaus. Eracles* 34.1, RHC Oc 2, p. 437, trans. Shirley, p. 137*Annales de Terre Sainte*, ed. Rohricht and Raynaud, B p. 19 (443). Cf. Marino Sanudo, *Liber secretorum* 3.12.2, ed. Bongars, p. 218, trans. Lock, p. 346.
[741] *...geterent les uns as autres de plusors manieres d'engins et grans et petis, et tel engein avet quy getet une piere si grant quy pexet c rotes, et avoient les engins chascun son nom.* Templar of Tyre, *Gestes des Chiprois* 270, ed. Minervini, p. 64, trans. Crawford, p. 23. The largest Genoese engines were named *Boverel* and *Vincheguerre*, and another was named *Peretin*. One of the Venetian engines was called *Marquemose*.
[742] Templar of Tyre, *Gestes des Chiprois*, trans. Crawford, p. 24 n. 4.

considered; however, the heavier Syrian measures would more likely have been used than the lighter, more reasonable, Egyptian measure. Although there is mounting evidence for the use of increasingly large counterweight trebuchets, there is no physical evidence to support the existence of projectiles much more than about 50 kg and the clean figure was probably intended to communicate an impression of scale rather than an accurate measure of weight.

The conflict between the Genoese and Venetians entered a new phase from 1256, triggered by a dispute over possession of a building in Acre that belonged to the Orthodox monastery of St Sabas. According to the *Rothelin* account,

> [A]t least sixty engines, every one of them throwing down onto the city of Acre, onto houses, towards towers and turrets, and they smashed and laid level with the ground every building they touched, for ten of these engines could deliver rocks weighing as much as 1,500 pounds weight of Champagne.[743] This meant that nearly all the towers and strong houses of Acre were destroyed...[744]

At the climax of this struggle in 1258, the Templar of Tyre notes that the Genoese gathered a fleet of forty-eight galleys and four *nefs*, each of the latter supported an *engin*, adding a naval element to the artillery battle taking place in Acre.[745] Although the Venetians were eventually able to push the Genoese out of Acre, the rivalry and factional fighting would drag on and continue to divide the Franks while another major power was rising in Egypt.[746]

There appears to be evidence that heavy artillery was used with increasing regularity from the time of the Third Crusade. New terminology was used by Frankish sources to identify engines at the siege of Damietta in 1218 and at the intra-Frankish sieges around 1230,

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[743] This mass is equivalent to 660 kg if the modern Troy pound is used.

[744] *Et tout cel an ot bien LX angins, qui tuit gitoient a val la cite d'Acre seur les messons et sor les torz et seur les tornelles, et abatoient et fondoient jusques en terre quan qu'il les consivoient, car il i avoit tiex X engyns, qui ruoient si grosses pierres et si pesanz que eles pesoient bien XV C livres aus poiz de Champainge. Dont il avint que prez que toutes les torz et les forz maissonz d'Acre furent... Rothelin* 79, RHC Oc 2, p. 635, trans. Shirley, p. 117.

[745] Templar of Tyre, *Gestes des Chiprois* 281, ed. Minervini, p. 68, trans. Crawford, p. 27. See also *Eracles* 34.3, RHC Oc 2, p. 443, trans. Shirley, p. 141; Marino Sanudo, *Liber secretorum* 3.12.5, ed. Bongars, pp. 220-21, trans. Lock, pp. 349-50. This was not the first occasion that war had broken out in Acre: Frederick II had besieged the Templar complex in 1229 and the Ibelins had besieged the Hospitaller complex for around six months in the early 1240s, Philip of Novara, *Gestes des Chiprois* 138, 222-23, ed. Raynaud, pp. 50, 126-27, trans. La Monte, pp. 91, 172-74. See also *Annales de Terre Sainte*, ed. Rohricht and Raynaud, A and B p. 17 (441).

[746] For an extremely hostile opinion of this rivalry and its ultimate cost, see Ludolph of Suchem, *De itinere Terrae sanctae liber* 26, ed. Deycks, p. 42, trans. Stewart, pp. 54-55.

while the *manjaniq maghribi* also appears with increasing frequency in Muslim accounts.[747] Although the heaviest engines were still incapable of breaching fortifications, even after months of bombardment on some occasions, there appears to have been a continual process of technical development and experimentation. This is suggested by the use of only one, or very few, of these larger engines and their perceived impressiveness, evident at sieges such as those of Acre (1190-91), Damietta (1218-19), Kantara (1229-30), Beirut (1231-32), Homs (1248-49) and Mansura (1250).

The familiarity that the Franks and Muslims had with their rivals' technology, apparent during the Third Crusade, seems to have continued. The frequency with which al-'Adil and his descendants moved between the power-centres of Egypt and Syria would have contributed to this diffusion of knowledge: even if certain engines and experts remained tied to specific regions, high-level military figures would have been able to examine closely the engines in each arsenal. Even certain Franks were privy to these opportunities to examine a neighbour's artillery: officials were able to buy arms, siege engines and war materials from the inhabitants of Damascus as part of their agreement with al-Salih Isma'il and less than a decade later Louis IX's artilleryman, John the Armenian (*qui estoit artillier le roy*), went there to buy horn and glue for crossbows.[748] Such peacetime interactions would have added to the information exchanged during hostilities as various powers arrayed their artillery technology against each other.

It is still hard to discern the scale of the largest mid-thirteenth-century engines: while masts of ships may have been used to build some, others were apparently erected in just twenty-four hours. Although the physical evidence (projectiles) from Ascalon is rather vague and unique at this point, the significance of such finds dating to the Mamluk period are the best indicators of the scale of late-thirteenth-century artillery.

[747] See Appendix 3.
[748] Al-Maqrizi, *al-Suluk*, trans. Broadhurst, pp. 262-63; John of Joinville, *Vie de Saint Louis* 446, ed. and trans. Monfrin, pp. 218-19.

7. Artillery in the Mamluk Period

Physical Evidence (1260-1291)

Following the death of al-Salih Ayyub and the murder of his son al-Mu'azzam Turanshah in 1250, Izz al-Din Aybak became the first Mamluk sultan of Egypt. The ongoing intra-Muslim struggle for regional power continued, however, until Hulagu's campaign through Syria and Palestine in 1259-60.[749] Qutuz, who had been the effective leader of the Mamluks since Aybak's murder in 1257, defeated the Mongols at 'Ayn Jalut on 3 September 1260 and remained in power just long enough to extend Mamluk authority across most of western Syria. It was left to his successor, Baybars, to reveal the potential of Mamluk artillery.[750]

In the spring of 1263, Baybars moved his army into Palestine, having resolved to acquire Kerak from al-Mughith, his last remaining rival between Cairo and Aleppo. As a sideshow to this, he briefly tested the strength of Acre's defences from the morning of 14 April until he withdrew from the area on 16 April.[751] Peter Thorau has suggested that Baybars brought siege engines with him on this campaign but Ibn 'Abd al-Zahir, Baybars' secretary and biographer, makes no mention of any during the assaults on Acre or at any other point during the ninety-five-day campaign. The source states that craftsmen travelled with the army but that when the army reached Transjordan Baybars only ordered the provision of ladders.[752] It would appear, therefore, that Baybars had little intention of

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[749] For the last portion of these conflicts, see Ibn 'Abd al-Zahir, *al-Rawd*, trans. Sadeque, pp. 80-93. See also Thorau, *The Lion of Egypt*, pp. 54-69.

[750] Qutuz, then sultan, and Baybars, who would soon succeed him, were entertained in Acre ahead of the battle, inadvertently giving Baybars the opportunity to view some of Acre's defences from within, *Rothelin* 81, RHC Oc 2, pp. 637-38, trans. Shirley, pp. 118-19; *Eracles* 34.3, RHC Oc 2, p. 444; Ibn 'Abd al-Zahir, *al-Rawd*, trans. Sadeque, pp. 193-95; Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 2:437-38. Baybars' visit to Acre is emphasised in Boase, *Kingdoms and Strongholds*, p. 204 and Bartlett, *Islam's War*, p. 239. For the murder of Baybars, see Ibn 'Abd al-Zahir, *al-Rawd*, trans. Sadeque, pp. 96-98, 111, 123-34.

[751] Ibn 'Abd al-Zahir, *al-Rawd*, trans. Sadeque, pp. 139-40, 164-71, 173-75; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:43-44, 56-59; *Eracles* 34.4, RHC Oc 2, pp. 446-47.

[752] Ibn 'Abd al-Zahir, *al-Rawd*, trans. Sadeque, pp. 178-82; Thorau, *The Lion of Egypt*, p. 138.

using artillery against either Acre or Kerak, instead opting to use assault troops and miners.

Baybars faced a growing threat from the Mongols in 1263-64, as Hulagu received support from both the Byzantines and Kublai. The emboldened Franks were confident enough to launch raids through Palestine in 1264. Baybars responded by ordering limited raids around Caesarea and 'Atlit, weary of committing his forces with the far greater Mongol threat looming beyond the Euphrates.[753]

Baybars' Early Artillery

Baybars was in Egypt when he received word that Mongol forces had laid siege to al-Bira (Birecik) in early 1265. He dispatched an advance force and followed with the bulk of the army, reaching Gaza on 9 February. There, Baybars learned that the Mongols had erected seventeen trebuchets against al-Bira, fifteen of which focused on a certain tower. A letter arrived six days later informing the sultan that the Mongols had withdrawn with the arrival of the troops that he had sent ahead.[754]

Among the instructions that Baybars issued for the refortification of al-Bira, was that wood and stones be collected for the defensive artillery within the town, suggesting that such engines had been present, and presumably used, during the siege.[755] Baybars had additional engines sent to al-Bira from Shayzar, which were in turn replaced by engines from Damascus.[756] Although artillery appears to have been stockpiled in certain strongholds since at least the second half of the twelfth century, Baybars would repeatedly exploit this network of arsenals with far greater effect than any of his predecessors. Having ordered that some engines be sent to al-Bira, Baybars summoned others as his attention turned to Caesarea.

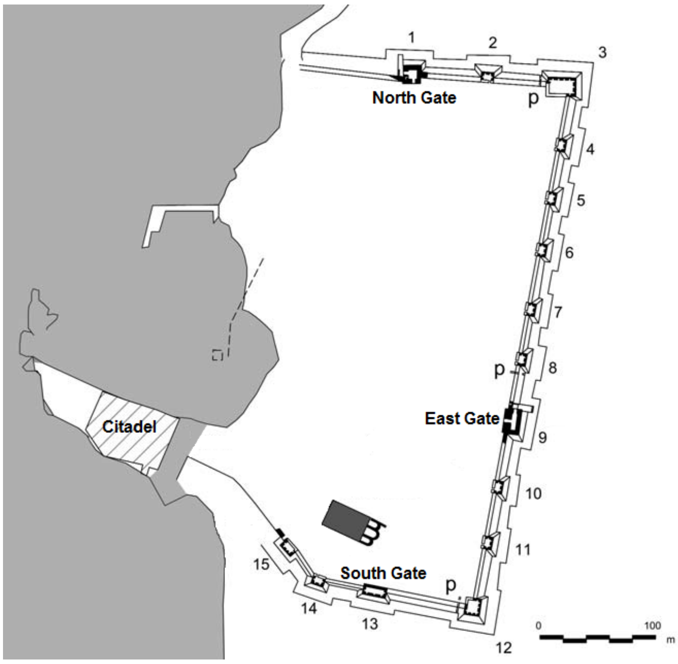
[753] Ibn 'Abd al-Zahir, *al-Rawd*, trans. Sadeque, pp. 186-91, 208-9, 216; Marino Sanudo, *Liber secretorum* 3.12.7, ed. Bongars, p. 222, trans. Lock, p. 351; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:67.
[754] Ibn 'Abd al-Zahir, *al-Rawd*, trans. Sadeque, pp. 237-39, cf. trans. al-Khowayter, 2:547-49; Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, pp. 473-74; Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 205; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:473-74, 503-4. See also Thorau, *The Lion of Egypt*, pp. 158-59.
[755] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:248-50, 252.
[756] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:253.

Caesarea: 1265

Free from the obligation of relieving al-Bira, Baybars reconnoitred the area around Caesarea on 25 February, under the pretence of hunting in the forests around Arsuf. While he was away, wood to construct artillery and ammunition were brought to the Mamluk camp at al-'Auja. Upon his return, Baybars had 'Izz al-Din al-Afram erect several trebuchets of the 'Maghribi' and 'Frankish' types from the timber that had arrived. Four large engines, as well as some smaller ones, were ready by the end of the following day. The army then moved to an advanced position and at midnight it prepared for the short march to Caesarea, arriving before dawn on 27 February.[757]

Caesarea's twelfth-century defences had been destroyed by Saladin in 1191 and the town had remained largely defenceless until the initial refortification efforts of 1217-18. Louis IX later developed the town defences in 1251-52.[758] Despite these efforts, the Mamluks took the town in a frontal assault on the first day of the siege, compelling the Frankish defenders to withdraw to the citadel.[759] Al-'Ayni's assertion that mangonels were used against the town defences appears inaccurate; although the engines just prepared would have accompanied the army, there would appear to have been little time to use them.[760] Furthermore, there are few indications of

Caesarea: town, plan (after Mesqui)



[757] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:554-55; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:69. See also Thorau, *The Lion of Egypt*, p. 160.

[758] Pringle, "Town Defences," pp. 89-90; Benvenisti, *The Crusaders*, p. 138; Müller-Wiener, *Castles of the Crusaders*, p. 74; Negev, "Caesarea," (1961), pp. 81-83; Willbrand of Oldenburg 2.2, ed. Pringle, p. 131, trans. Pringle, p. 86. For the town defences and citadel, see Mesqui, "L'enceinte médiévale de Césarée"; Faucher, Merlin and Mesqui, "Césarée," pp. 1-3; Pringle, "Town Defences," pp. 90-91; Benvenisti, *The Crusaders*, pp. 141-44; Negev, "Caesarea," (1960), pp. 264-65. See also, Conder and Kitchener, *Survey of Western Palestine*, 2:13-16, 23-26, 28. Cf. Frova, "Caesarea," 1962, pp. 150-51.

[759] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:555-56; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:70.

[760] Al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 219.

Caesarea: eastern section of the town walls, from the south (author)

impact signatures along the faces of the surviving fortifications. Artillery was, however, erected against the citadel.

Baybars' mastery of logistics is revealed during the second phase of the siege: thousands of arrows brought from 'Ajlun were distributed while arrangements were made for the collection of firewood and ammunition for the artillery. Baybars evidently found the transportation, deployment and then operation of his trebuchets agreeable, as Ibn 'Abd al-Zahir states that robes of honour were given to 'Izz al-Din al-Afram, *amir jandar*, who had been responsible for preparing these engines ahead of time, and to the men who then worked them. But artillery did not breach the walls of the citadel. Instead, it was surrendered on 5 March: the Franks either evacuated it by sea the night before or formally surrendered it the following morning. Caesarea's fortifications were then destroyed by the Mamluks.[761]

Caesarea: citadel, from the southeast in 1887 (from Schiller)

Image protected by copyright

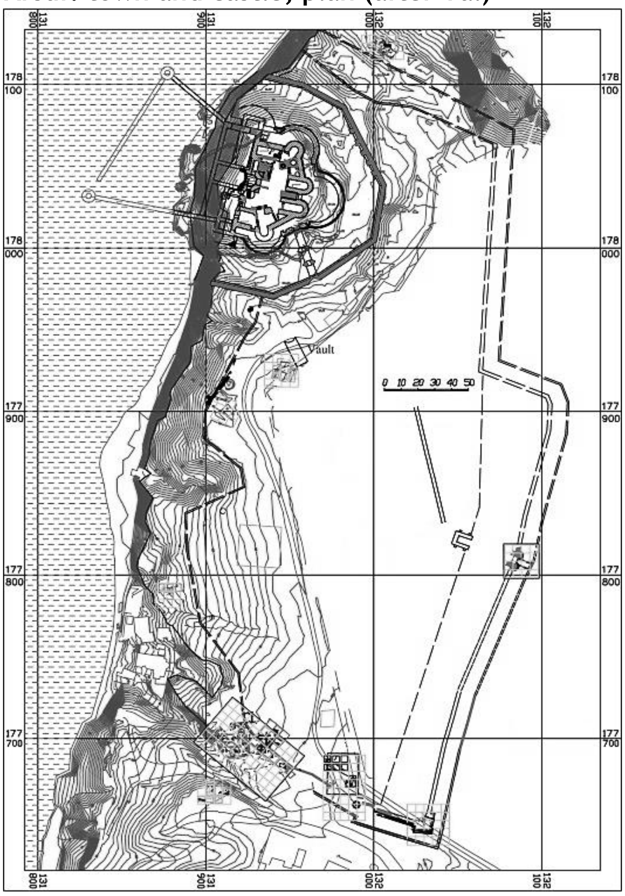
[761] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:556-57; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:70-71. See also al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, pp. 219-20; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:474; *Annales de Terre Sainte*, ed. Röhricht and Raynaud, A and B pp. 27-28 (451-52), ed. Edbury, p. 158; Templar of Tyre, *Gestes des Chiprois* 328, ed. Minervini, p. 96, trans. Crawford, p. 44; Marino Sanudo, *Liber secretorum* 3.12.7, ed. Bongars, p. 222, trans. Lock, p. 351; Thorau, *The Lion of Egypt*, pp. 160-61.

From Caesarea, Baybars travelled to 'Atlit and burnt its gardens while a secondary force occupied and then destroyed Haifa, which had been abandoned by its garrison.[762] Shortly after Baybars had returned to Caesarea to monitor its destruction, Sayf al-Din al-Zayni arrived with artillery from Subayba and further war materials, possibly ammunition, arrived from Damascus.[763] These engines were soon put to use against Arsuf.

<u>Arsuf: 1265</u>

John of Ibelin, lord of Beirut, had acquired Arsuf by marriage in the 1190s. The town lay in ruins from the time of the Third Crusade until at least 1211, and may not have been refortified until 1241, when it is recorded that John's son, John of Arsuf, strengthened the site. In 1253 John of Joinville remarked that the castle was strongly fortified (*moult estoit fort*). Balian of Ibelin, son of John of Arsuf, sold the site to the Hospitallers in 1261 and the order's subsequent work to develop the castle was used by Baybars as a pretext to reject Frankish overtures of peace in 1263.[764]

Arsuf: town and castle, plan (after Tal)



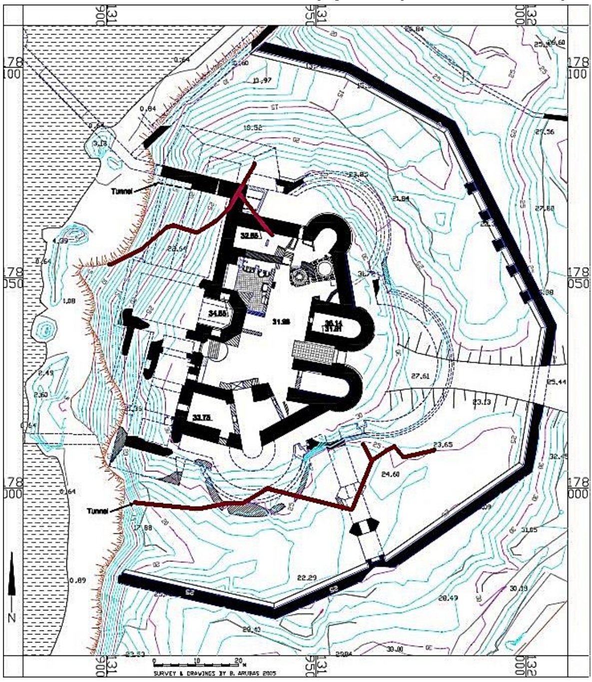
The citadel was taken on 5 March (15 Jumada I) according to Ibn 'Abd al-Zahir and those following him (such as Ibn al-Furat), 7 March according to the Templar of Tyre, and 8 March (18 Jumada I) according to the Edbury edition of the *Annales de Terre Sainte*, Yunini and those following him (such as Mufaddal). The Franks departed by sea in the versions provided by Ibn 'Abd al-Zahir and Yunini while Ibn al-Furat claims that the garrison surrendered. The Frankish sources state that the garrison went by sea to Acre but do not specify if this occurred after a formal surrender or not. For testimony of the town's destruction a century and a half later, see John Poloner, *Descriptio Terrae Sanctae*, trans. Stewart, p. 29.

762 Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:561; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:72; al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 220.

763 Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:562; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:72.

764 Wilbrand of Oldenburg, *Itinerarium terrae sanctae* 2.2, ed. Pringle, p. 132, trans. Pringle, p. 86; *Annales de Terre Sainte*, ed. Röhricht and Raynaud, A and B p. 16 (440), B p. 26 (450), ed. Edbury, pp. 153, 157;

Arsuf: castle and tunnels, plan (after Arubas)



Baybars arrived at Arsuf on either 15 or 21 March 1265.[765] The Muslims initially attempted to fill the fosse with timber; however, the Franks managed to tunnel under this from the castle and set fire to the wood. The Mamluks then appear to have dug a parallel beyond the counterscarp, allowing them to take the town in a general assault on 26 April. The castle held out until 30 April; when a section of wall was undermined, the garrison surrendered. Before being led away into captivity, the Frankish prisoners were compelled to take part in demolishing Arsuf's defences.[766]

Arsuf: castle, from the south (author)

Philip of Novara, *Gestes des Chiprois* 220, ed. Gaston, p. 124; John of Joinville, *Vie de Saint Louis* 563, ed. and trans. Monfrin, p. 278; *Eracles* 34.4, RHC Oc 2, p. 446, trans. Shirley, p. 142; Templar of Tyre, *Gestes des Chiprois* 328, ed. Minervini, p. 96, trans. Crawford, p. 44; Marino Sanudo, *Liber secretorum* 3.12.6, ed. Bongars, p. 221, trans. Lock, p. 350; Ibn 'Abd al-Zahir, *al-Rawd*, trans. Sadeque, p. 168. See also Benvenisti, *The Crusaders*, p. 132; Deschamps, *Les Châteaux*, 2:18. See also the account of Ibn Shaddad, in Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:73. For the site of Arsuf, see Roll, "Introduction," 41, 44-45; Conder and Kitchener, *Survey of Western Palestine*, 2:137-38.

765 The Frankish sources provide the former date while the latter is given by Ibn 'Abd al-Zahir and Ibn Shaddad, as well as their followers.

766 Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:562-64, 568-72; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:73-74, 76-78. See also Templar of Tyre, *Gestes des Chiprois* 328, ed. Minervini, p. 96, trans. Crawford, p. 44; *Eracles* 34.6, RHC Oc 2, p. 450; *Annales de Terre Sainte*, ed. Röhricht and Raynaud, A and B p. 28 (452), ed. Edbury, p. 158; Marino Sanudo, *Liber secretorum* 3.12.7, ed. Bongars, p. 222, trans. Lock, pp. 351-52; al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, pp. 220-21; Amitai, "The Conquest of Arsuf," pp. 69-72; Roll, "Introduction," p. 17; Thorau, *The Lion of Egypt*, pp. 161-62; Benvenisti, *The Crusaders*, pp. 132-33. For the tunnels found under the castle, see Roll, "Introduction," p. 17 n. 36; Amitai, "The Conquest of Arsuf," pp. 70-71.

Arsuf: piles of projectiles (author)

Nearly all accounts of this siege emphasise the Muslims' use of artillery. The engines are portrayed, in most accounts, as providing cover for the sappers and their extensive excavations. Ibn 'Abd al-Zahir describes men hauling on ropes in his discussion of these engines.[767] While this could refer to the process of drawing back the main arm of a counterweight trebuchet, it is at least as likely to have referred to the firing of traction engines. In either case, Baybars had accumulated a considerable assortment of engines by this point in the campaign.

Before the siege had begun, Baybars would have had at his disposal the engines that were constructed ahead of the siege of Caesarea as well as those that had arrived from Subayba.[768] The former are likely to have been no larger than those used by Saladin in

Arsuf: tooled projectiles (author)

[767] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:564, 566; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:75.

[768] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:554-55, 562; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:69, 72;

Arsuf: inner gateway, from the east (author)

the 1180s, as they required a similar twenty-four hour period to prepare. The latter were quite possibly larger. Additionally, prefabricated engines had arrived from Damascus, their disassembled components having been carried to Arsuf on men's shoulders. Another engine, built on site by Karmun Agha, is refered to as an engine of seven arrows, suggesting its throwing beam consisted of seven spars. Collectively, command of these trebuchets fell to 'Izz al-Din al-Afram, who is again celebrated for his conduct in this capacity.[769] The value necessarily associated with the prefabricated engines, suggests that they were counterweight trebuchets.[770] The rapid construction of the engines that were

Arsuf: outer southern tower, from the southeast (author)

[769] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:566; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:76.
[770] Following the siege they were redistributed among certain strongholds, including Kerak and 'Ajlun, Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:82.

Arsuf: projectiles *in situ*, northern part of the fosse (author)

prepared before the siege of Caesarea and the impracticality of using counterweight trebuchets to support sapping efforts, suggest that a number of traction trebuchets complimented the heavier engines. The physical evidence also confirms that the majority of projectiles were cast by traction engines.

By 2005, archaeological excavations in the area of the castle had uncovered 2,747 stone artillery projectiles, 800 of which were weighed. The average mass of the weighed sample is about 10 kg, with eleven stones weighing over 70 kg and almost fifty weighing less than 3 kg.[771] The impracticality of counterweight engines throwing stones at the light

[771] Raphael and Tepper, "The Archaeological Evidence," pp. 85, 87, see also Chart 1A.

Arsuf: marble column sections (author)

end of this range and traction engines throwing stones at the heavy end appears to confirm the use of both types of trebuchet. The vast majority of projectiles are between 2 and 20 kg, reflecting both the use of many light engines as well as the rate of fire of such engines.

A concentration of heavier stones, averaging about 25 kg (most 20-35 kg), was discovered just north of the castle's inner gate among some burnt cedar logs.[772] The presence of these stones would suggest that a reasonably large engine was used to target a wooden shelter between the castle's inner and outer walls. Determining where other engines were positioned is more difficult.

Projectiles found in the fosse have not yet been studied; however, the highest concentration of those discernible in the surface layer of fill is to the north of the castle. Similarly, the highest concentrations of impact signatures are found in the surviving sections of the outer northern walls. Together, these confirm that most projectiles were thrown against the castle from the north. A significant number of projectiles (1,112), 40% of those discovered within the castle, along with 65% of the discovered arrowheads, were found around the inner gate, suggesting that this was a focal point during the siege. The concentration of impact signatures on the northern and eastern faces of the flanking towers suggests that most stones were thrown from the east or northeast. Certain sections of the castle's outer southern wall have survived in a better state of preservation than those to the north; however, impact signatures on these sections reveal that the Mamluks erected at least one engine to the south of the castle after the town fell on 26 April.

The large number of projectiles recovered (and many more that could yet be excavated from the surrounding fosse), their size and the apparent targeting of gateways

[772] Raphael and Tepper, "The Archaeological Evidence," p. 87.

and parapets, evident by the number of stones found inside the castle, appear to confirm that the majority of the Mamluk engines were traction trebuchets. Although limited, the power of these engines was still sufficient to warrant importing ammunition – almost all of the projectiles are limestone, most likely sourced from the base of the Samarian hills about 15 km to the east.[773]

Arsuf: large marble columns, some with rounded ends (author)

Although most of the projectiles found inside the castle were probably thrown by the Mamluks, it is possible that some of these were intended for defensive use. It is hard to imagine that the garrison would have had much of its original stockpile left after five weeks of siege; however, they could have reused projectiles that were thrown into the castle or even have begun to harvest ammunition from the marble columns found within the castle. While it should not be concluded that all of the marble projectiles found inside the castle were shaped by the defenders, a number of columns display rounded ends, suggesting that the defenders may have begun destroying parts of their own castle to produce ammunition before it fell.

When Baybars left Arsuf on 11 May 1265, the demolition having been completed, Ibn al-Furat claimed that the back of Frankish power had been broken.[774] Although most of southern Palestine had been lost by this point, Acre was still a bastion of Frankish influence on the coast and Safed was a clear symbol of Frankish power in Upper Galilee.

[773] Raphael and Tepper, "The Archaeological Evidence," pp. 87-88.
[774] Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:82.

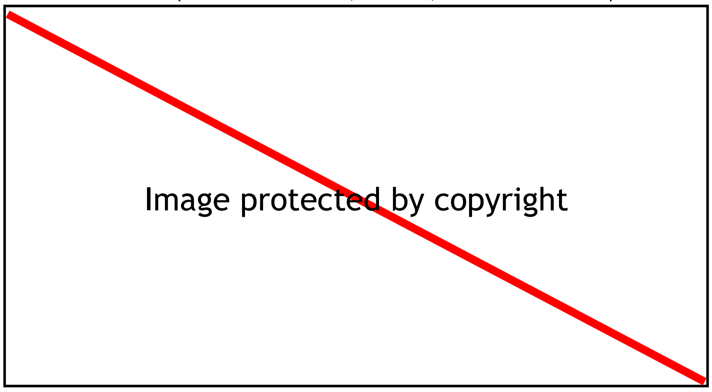
Seizure of the Strongholds of the Upper Galilee

Safed: 1266

According to Ibn al-Furat, the castle of Safed was built by the Templars in 1101-2.[775] While some modern historians have accepted this dating, believing it to have been commissioned by Tancred or Hugh of St Omer, others have favoured certain Frankish accounts, such as those of James of Vitry and Marino Sanudo,[776] which credit the castle's construction to Fulk around 1140.[777] The castle was destroyed by Mu'azzam 'Isa around 1220 but the Templars began to refortify it when it returned to them in 1240, aided significantly by the efforts of Benedict (Benoit) of Alignan, archbishop of Marseilles.[778]

Hulagu died in 1265, providing Baybars with the opportunity to turn his attention towards Palestine. In May 1266 Baybars marched his army out of Egypt. An advance force, which had been sent to Homs, raided around Tripoli while contingents of the main body raided the coast from Arsuf to Tripoli and inland towards Montfort.[779] At the same time, Syrian forces invaded eastern Galilee, blockading Safed and Beaufort. Coordinating his forces from a camp outside of Acre, Baybars

Safed: castle (J. M. Bernatz, 1837, from Schiller)



[775] Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:88.

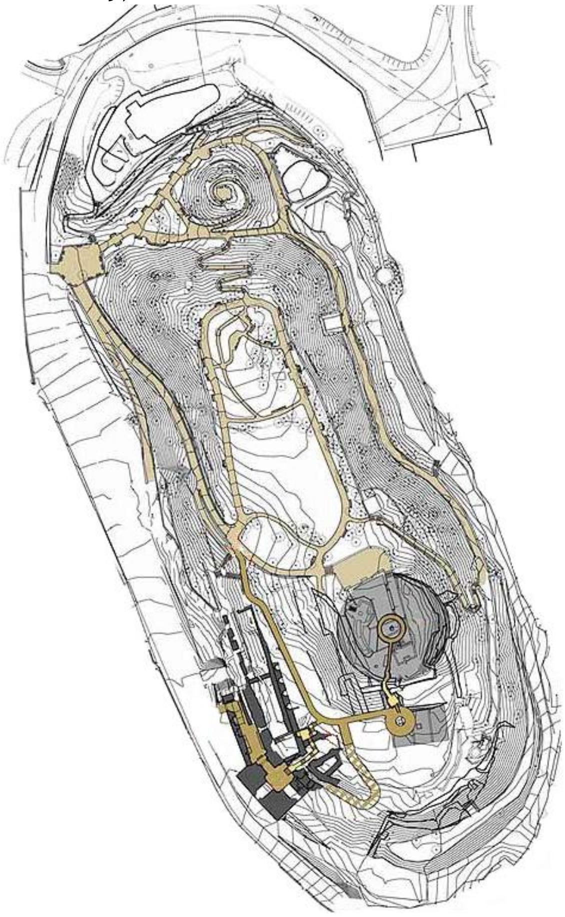
[776] James of Vitry, *Historia orientalis* 49, ed. Donnadieu, p. 217, trans. Stewart, p. 25; Marino Sanudo, *Liber secretorum* 3.6.18, ed. Bongars, p. 166, trans. Lock, p. 264.

[777] For the former, see Kennedy, *Crusader Castles*, p. 40; Benvenisti, *The Crusaders*, pp. 202-3; Deschamps, *Les Châteaux*, 2:119, 125. For the latter, see Boas, *Crusader Archaeology*, p. 118; Boase, "Military Architecture," pp. 159-60. William of Tyre first mentions the castle as the place where Baldwin III took refuge in 1157, while there appears to be no administrative record of the castle earlier than when it was granted to the Templars by Amalric in 1168, William of Tyre, *Chronicon* 18.13-14, ed. Huygens, 2:828-32, trans. Babcock and Krey, 2:258-62; Pringle, *Churches*, 2:206.

[778] *De constructione castri Saphet*, ed. Huygens, pp. 378-87, trans. Kennedy, 190-98; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:88-89. For studies of the castle, see Barbé, "Zefat"; Barbé and Damati, "Le château de Safed," pp. 77-93; Pringle, "Reconstructing the Castle of Safad," pp. 139-49; Benvenisti, *The Crusaders*, pp. 199-204; Huygens, "Un nouveau texte," pp. 360-77; Conder and Kitchener, *Survey of Western Palestine*, 1:248-50.

[779] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:582, 584-87; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:84-87; al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 221. See also Templar of Tyre, *Gestes des Chiprois* 346, ed. Minervini, p. 108, trans. Crawford, p. 50; *Eracles* 34.9, RHC Oc 2, p. 454; Marino Sanudo, *Liber secretorum* 3.12.8, ed. Bongars, p. 222, trans. Lock, p. 352; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:490; Thorau, *The Lion of Egypt*, 167-68.

Safed: castle, plan (after Israel Antiquities Authority)



sent for artillery from Damascus while new engines were constructed in the camp. With the return of his coastal raiders, Baybars marched on Safed, where he encamped his army on 13 June 1266.[780]

While Baybars waited for his artillery, receiving envoys while doing so, his sappers began to work against the castle.[781] The engines from Damascus reached the Jordan on 26 June and 'Izz al-Din al-Afram was sent to help convey them from Jacob's Ford to Safed. The first trebuchets came into action on 1 July but the less glorious work of the miners was again far more productive in breaking down Safed's defences, ultimately forcing the Franks to countermine. On 19 July a seam appeared in the outer wall above one of the mines. With this wall compromised, the Franks burnt and abandoned their outer defences (*al-sata'ir*), allowing the Muslims to scale the outer wall. Mining efforts then commenced against the inner castle.[782] The garrison surrendered on terms of safe conduct soon after, but were executed after exiting the castle.[783] Upon gaining Safed, Baybars immediately used it as an armoury, storing within it the artillery that he had just used against the castle.[784]

[780] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:587-88; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:89; al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, pp. 222-23.

[781] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:588-91; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:89-91.

[782] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:591-95; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:91-93. Cf. al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 222. See also Mufaddal, *Kitab*, ed. and trans. Blochet, 1:490.

[783] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:595-99; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:94-96. Cf. Templar of Tyre, *Gestes des Chiprois* 346-47, ed. Minervini, pp. 108-10, trans. Crawford, pp. 50-51; al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, pp. 222-23; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:490-93. See also *Eracles* 34.9, RHC Oc 2, p. 454; *Annales de Terre Sainte*, ed. Röhricht and Raynaud, B p. 28 (452), ed. Edbury, p. 158; Marino Sanudo, *Liber secretorum* 3.12.8, ed. Bongars, pp. 222-23, trans. Lock, p. 352; Thorau, *The Lion of Egypt*, pp. 169-70.

[784] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:600; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:96 al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 223.

There are conflicting indications of how large these trebuchets were. On one hand, the engines would appear to have been quite large: they required two weeks to be brought from Damascus and were not used to protect the sappers during their early efforts to undermine the castle's outer defences. Furthermore, their importance is emphasised as Baybars and his entourage are said to have taken part in dragging along the components that were carried by oxen. On the other hand, they are not described as inflicting any notable damage, and Ibn 'Abd al-Zahir claims that they were carried from Damascus on men's shoulders.[785] The artillery that Baybars was said to have commissioned outside Acre is not mentioned during the early part of the siege, suggesting it consisted of light engines, almost certainly used to support the miners, as distinct from the heavier machines brought from Damascus.

Among the artillery that came into action on 1 July, was an engine of the 'Maghribi' type.[786] To convey this engine the 13 km (as the crow flies) from Jacob's Ford and then render it operational appears to have taken five days. When considering that engines of this designation are noted at the siege of Arsuf, it seems reasonable to postulate that they were counterweight trebuchets that threw stones about 20-40 kg – so grand that only one is noted during this siege but smaller than the 'Frankish' engines, as will become apparent below.

It is hard to determine where the Mamluk artillery was positioned. Unlike at Arsuf, where Baybars is described as walking between his artillery and siege works, he is described as riding to and from his artillery at Safed. This probably reflects the distance between these engines and other siege works, given the much greater circumference of this castle, rather than an exceptional distance between the trebuchets and the castle.[787] The only indication of range comes from Ibn 'Abd al-Zahir's testimony that Baybars climbed up the first of the 'Maghribi' engines ready for use and ordered its crew to target a prominent house.[788] Although the positions of the engine and house are unknown, the anecdote gives the impression that Baybars was relatively free to select his targets.

[785] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:588, 591; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2: 89, 91. Ibn 'Abd al-Zahir initially claims that the engines were carried from Damascus on men's shoulders, he then states that as they neared Safed they could not be carried by camel, requiring men from all stations to help carry them to the castle. How the oxen that were involved in moving certain components relate is unclear.
[786] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:591-92; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:91. See also Mufaddal, *Kitab*, ed. and trans. Blochet, 1:490.
[787] For example, Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:593; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:92.
[788] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:592.

The defenders of Safed also appear to have employed artillery. This was used, according to the Templar of Tyre, to throw back a gift that Baybars had sent at the start of the siege and Ibn 'Abd al-Zahir appears to indicate that the stone which killed a certain emir one night was thrown in this way.[789] Neither the artillery that Baybars may have found within the castle nor any of the engines that he had used to attack it appear to have been taken on his subsequent campaign into Cilicia.[790]

Baybars returned to Safed in 1267 and oversaw its development.[791] Although some sources emphasise that Baybars focused on improving the ditch, it may have been at this point that construction of the massive circular keep began.[792] In response to a threat from the Mongols, Baybars briefly left Safed for Damascus, where he is described as depositing artillery. It is unclear whether the engines that he left at Damascus had been brought from Egypt, or were simply brought back from Safed, where they had been kept since the previous summer. As in 1263, Baybars does not appear to have employed any artillery during the assaults that he made on Acre in May 1267.[793]

Beaufort: 1268

With new threats of a Mongol invasion of Syria, Baybars moved his army from Egypt to Palestine in February 1268. Baybars wrote ahead to prepare his Syrian governors and ordered Damascene forces to establish a blockade around Beaufort, the latter coincidentally arriving before a contingent of its defenders had returned from the coast.[794] As he moved north, Baybars took (on 7 March) and destroyed the citadel of Jaffa, which had been rebuilt by Frederick II and Louis IX.[795] From Jaffa, Baybars dispatched a force

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789 Templar of Tyre, *Gestes des Chiprois* 346, ed. Minervini, p. 108, trans. Crawford, p. 50; Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:592.

790 See Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:600, 608-13; Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 2:445-46.

791 Abu Shama, *Kitab al-Raudatain*, RHC Or 5, p. 205; Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:622-23, 628; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:101; al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 224. He also returned to inspect the refortification efforts in 1268, between destroying Jaffa and besieging Beaufort, Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:641.

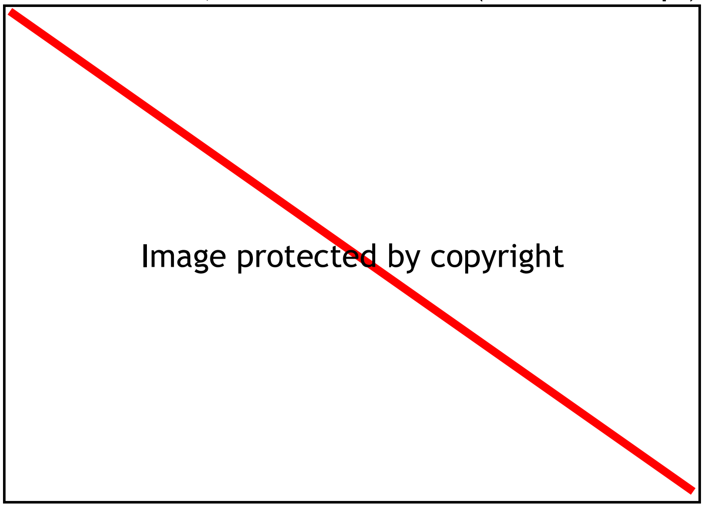
792 See also Pringle, "Reconstructing the Castle of Safad," pp. 143-48; Pringle, *Churches*, 2:206; Pringle, *Secular Buildings*, no. 191, pp. 91-92; Conder and Kitchener, *Survey of Western Palestine*, 1:250; Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:630.

793 *Annales de Terre Sainte*, ed. Röhricht and Raynaud, A and B, p. 29 (453), ed. Edbury, p. 159; *Eracles* 34.10, RHC Oc 2, p. 455; Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:623-24; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:102-3.

794 Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:636-37; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:105-6. For Haitum's petition for Mongol support, see also Bar Hebraeus, trans. Budge, *Makhtebhanuth Zabhne*, 2:447.

795 Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:638-39; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:108; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:503-5 al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, pp. 225-26;

Beaufort: castle, from the northwest (from Deschamps)



to begin the siege of Beaufort, as artillery from Safed had already arrived there, and he reached the castle himself on 3 or 4 April. Two trebuchets were ready for action the day after he arrived and a total of twenty-six engines were operational a few days later.[796] According to Ibn 'Abd al-Zahir, funds contributed to support the Holy War by emirs who could not take part in the campaign were used to offset the expense of the crews working so many engines.[797]

Beaufort sits on the edge of a plateau overlooking the Litani. The site was under Damascene control from at least 1121 and appears to have been ceded to Fulk in 1139-40. Following Saladin's acquisition of the castle, it was developed by Al-Adil and was evidently defensible in 1240, although James of Vitry claims that, along with Safed and Banyas, it was in ruins in 1220. Ibn 'Abd al-Zahir judged Beaufort to be one of the strongest castles in the region and a threat to the territory of Subayba (Banyas).[798] In 1260, following the sack of Sidon, Julian of Sidon sold the castle to the Templars.[799]

The Templars built a second 'citadel' to the south of the castle, probably between 60 and 170 m from the south wall, presumably to deny this area of level ground to any potential besieger. Unable to defend this secondary strongpoint for more than a week in 1268, the Templars evacuated it on the night of 10-11 April, burning everything that they

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Eracles 34.11, RHC Oc 2, p. 456; *Annales de Terre Sainte*, ed. Röhricht and Raynaud, A and B p. 29 (453), ed. Edbury, p. 159. See also Thorau, *The Lion of Egypt*, pp. 187-8. Cf. events of 1263, Ibn 'Abd al-Zahir, *al-Rawd*, trans. Sadeque, pp. 237-38.

[796] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:640-43; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:110-11. See also al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 227; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:506.

[797] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:644; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:111-12. Cf. Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:635.

[798] Ibn al-Athir, *al-Kamil*, trans. Richards, 1:227 and n. 25; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:109-10; James of Vitry, *Lettres*, no. 6, p. 124; Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:641.

[799] *Eracles* 34.3, RHC Oc 2, p. 445, trans. Shirley, p. 142; *Annales de Terre Sainte*, ed. Röhricht and Raynaud, B p. 25 (450), ed. Edbury, p. 157; Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:641; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:110. For studies of the castle, see Conder and Kitchener, *Survey of Western Palestine*, 1:128-32; Rey, *Étude sur les monuments*, pp. 127-39; Deschamps, *Les Châteaux*, 2:197-208; Boase, "Military Architecture," p. 160; Pringle, *Secular Buildings*, no. 44, p. 31; Pringle, "Town Defences," p. 78; Kennedy, *Crusader Castles*, pp. 43, 128; Corvisier, "Les campagnes de construction," pp. 243-66; Yasmine, "Die Burg Beaufort," pp. 277-84.

could not carry out with them. The Muslims occupied this position the following morning and probably moved artillery in later that day. Artillery is described as bombarding the castle from the outer citadel from 12 April, while the Franks fired back with at least one engine that was mounted on a tower.[800]

Despite its proximity and relative safety within the Templar citadel, the Mamluks' artillery proved incapable of breaching the fortifications of Beaufort. Instead, the castle fell after dissent broke out among the defenders following Baybars' interception of a letter, which he substituted with one of his own before passing it along to the garrison. The castle's defenders, as many as 480 fighters, surrendered themselves into captivity on 15 April, while the women and children were escorted to Tyre.[801] After the siege, the external citadel, which had proven to be a liability, was destroyed while plans to develop other areas of the castle were implemented.[802] The Mamluk army then moved against the Mongols' Frankish ally, Bohemond VI of Antioch-Tripoli.

Antioch: 1268

When Baybars left Beaufort on 25 April 1268, he sent his heavy baggage, which probably included his artillery, to Damascus while certain detachments of his army were sent out in various directions. Without the burden of a baggage train, Baybars moved to Baalbek and from there was able to take the difficult road across the mountains of Lebanon and surprise the Franks of Tripoli by approaching from the south.[803] This allowed him to raid freely around the city; however, without his artillery, he declined to invest it or any of the nearby Frankish castles, despite having pretexts to do so.[804] Instead, he travelled to Antioch, via Homs, Apamea and Jisr ash-Shughr.

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[800] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:643-44; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:111.

[801] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:642-45; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:210-12; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:506-7. Cf. *Annales de Terre Sainte*, ed. Röhricht and Raynaud, A and B p. 30 (453), ed. Edbury, p. 159; Templar of Tyre, *Gestes des Chiprois* 365, ed. Minervini, p. 124, trans. Crawford, p. 59; *Eracles* 34.11, RHC Oc 2, p. 456.

[802] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:645-46; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:112.

[803] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:646-48, 653; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:116. See also al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 227; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:507; *Annales de Terre Sainte*, ed. Edbury, p. 160.

[804] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:654-56, 685-87; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:116-18. Cf. Mufaddal, *Kitab*, ed. and trans. Blochet, 1:507. Cf. Saladin's similar move against Beirut in 1182 (in Chapter 3) and Nur al-Din's acquisition of Munaytira, commanding the pass between Baalbek and Tripoli, in 1165-66, Ibn al-Athir, *al-Kamil*, trans. Richards, 2:161.

Baybars arrived at Antioch on 15 May and baggage, from an unclear origin, arrived three days later. The city was stormed on 19 May and the citadel surrendered the following day.[805] Notwithstanding Bartlett's suggestion that the Mamluks broke into the city through a breach, the lack of any mention of miners or siege engines along with the Mamluks' numbers and the extended circumference of Antioch's defences strongly suggest that the city was stormed in a frontal attack the day after the baggage arrived.[806]

The remaining Frankish strongholds of the north fell shortly afterwards. Most were abandoned and only Cursat (al-Qusair), the patriarch's castle, remained in Frankish hands by the end of 1268. With Frankish influence in the region all but removed, many Armenian strongholds farther north became the next targets.[807]

Although artillery does not appear to have been used at Antioch, it is highlighted in the letter that Baybars sent to Bohemond soon after the city's fall, bragging of his success. Among the other exploits that he recounts, Baybars claims that he cut all of the trees in the area save those that could be used for the beams of artillery.[808] Certain areas of Western Syria, unlike Palestine, would have supported tall coniferous trees. Although the wood of such is not as strong as certain hardwood types, these trees were often straight and thus ideal for constructing large counterweight trebuchets. While Baybars does not appear to have used any such trees on this occasion, his suggestion that he could is a reflection of his prowess: this region, effectively a farm for artillery timber, was now his. The association of these large trees with artillery, along with the appearance of stones over 50 kg at Arsuf, even if limited in number, indicates that the scale of the largest engines was steadily increasing through the 1260s. In the 1270s such engines would be employed in greater numbers.

Upon the failure of the Ninth Crusade and death of Louis IX, Baybars marched his Egyptian army into Palestine in 1271. After raiding around Tripoli and taking the

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805 Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:656-58, 678; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:121-22, 125-26; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:508. See also *Eracles* 34.11, pp. 456-57; Templar of Tyre, *Gestes des Chiprois* 365, ed. Minervini, p. 124, trans. Crawford, p. 59; *Annales de Terre Sainte*, ed. Edbury, p. 159; Marino Sanudo, *Liber secretorum* 3.12.9, ed. Bongars, p. 223, trans. Lock, p. 353; Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 2:448. For the city's state of destruction in the fourteenth century, see Ibn Battuta, *Tuhfat* 1.1, trans. Gibb, p. 61.

806 Bartlett, *Islam's War*, p. 247.

807 Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:678-80, 682-85; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:126-27; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:514; al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 228; *Eracles* 34.11, RHC Oc 2, p. 457; Templar of Tyre, *Gestes des Chiprois* 365, ed. Minervini, p. 124, trans. Crawford, p. 59; Vahram, *Chronicle*, trans. Neumann, pp. 50-53.

808 Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:659, trans. Gabrieli in *Arab Historians*, p. 310; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:510; al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 230.

Templar castle of Chastel Blanc, he prepared to invest the most formidable Frankish castles of the Homs-Tripoli corridor.[809]

Indications of Significant Power: 1271

Crac des Chevaliers: 1271

Crac des Chevaliers sits on the black basalt of Jabal Khalil, the most southerly extension of Jabal Ansariyya. Originally constructed by the Kurds in the eleventh century, Crac had fallen to the Franks by the end of the first decade of the twelfth century and had been acquired by the Hospitallers in the 1140s. The order may have begun to rebuild it from 1157 with work continuing until at least the late 1250s. All that survives today appears to postdate the earthquakes of 1170.[810] Crac was a frontier stronghold during the thirteenth century, as threatening to neighbouring Hama and Homs as it was threatened by them.[811] Baybars taunted the garrison at the end of January 1270, marching up to its walls without his baggage,[812] but his intentions were different when he returned the following year.

The siege of 1271 can be divided into four phases as the sources agree that certain obstacles were taken on 4/5 March, 21 March, and 29/30 March or 7/8 April.[813] However,

[809] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:742; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:143. For the castle of Chastel Blanc, see Rey, *Étude sur les monuments*, pp. 85-92; Deschamps, *Les Châteaux*, 3:249-58; Piana, "Die Templerburg Chastel Blanc," 293-301.

[810] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:746-47; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:144-45; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:530; Rey, *Étude sur les monuments*, pp. 265-70; Boase, *Kingdoms and Strongholds*, p. 80; Müller-Wiener, *Castles of the Crusaders*, p. 60; Zimmer and Meyer, "Le Krak des Chevaliers," p. 360; Kennedy, *Crusader Castles*, pp. 145-47. For comprehensive studies of the Crac des Chevaliers, see Deschamps, *Les Châteaux*, vol. 1; Biller, et al., *Der Crac des Chevaliers*; Zimmer, Meyer and Boscardin, *Krak des Chevaliers*; Mesqui, "Les programmes architecturaux"; Mesqui, "La troisième enceinte." See also Rey, *Étude sur les monuments*, pp. 39-67; Boase, "Military Architecture," pp. 153-56; Kennedy, *Crusader Castles*, pp. 145-63; Mesqui, "La fortification des Croisés," pp. 20-22.

[811] See Major, "Al-Malik al-Mujahid," pp. 61-75. Cf. Ibn Jubayr, *Rihla*, trans. Broadhurs, pp. 265, 268.

[812] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:729-30; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:139, 141.

[813] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:743-45; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:145-46; Ibn Shaddad, from Deschamps, *Les Châteaux*, 1:132-34 and King, "The Taking of Le Krak," pp. 88-89; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:527-29; Templar of Tyre, *Gestes des Chiprois* 376, ed. Minervini, pp. 136-38, trans. Crawford, p. 66; *Annales de Terre Sainte*, ed. Röhricht and Raynaud, B p. 31 (455), ed. Edbury, p. 160; Marino Sanudo, *Liber secretorum* 3.12.11, ed. Bongars, p. 224, trans. Lock, p. 355. Al-'Ayni gives an abbreviated version of Ibn 'Abd al-Zahir's timetable but dates events a month later. He also provides the account of Ibn Kathir, who confirms that the Franks surrendered ten days after the castle was breached, al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, pp. 237-38.

the differing vocabulary used by the sources allows for multiple interpretations of events when reconciling the surviving accounts with the architectural evidence.

Siege of Crac des Chevaliers, 1271

	Ibn 'Abd al-Zahir Ibn al-Furat	**Ibn Shaddad**	**Mufaddal**	***Annales de TS* Templar of Tyre Marino Sanudo**
18 February (6 Rajab)				Siege began
21 February (9 Rajab)	Baybars arrived/ castle first attacked			
3 March (19 Rajab)		Baybars arrived and artillery prepared	Artillery prepared	
4 March (20 Rajab)	*Rabads* taken			
5 March (21 Rajab)		First *bashura* fell	First *bashura* fell	
14 March (30 Rajab)	A number of trebuchets had been prepared			
21 March (7 Sha'ban)	*Bashura* stormed	Second *bashura* fell	Second *bashura* fell	
29 March (15 Sha'ban)		Third *bashura* fell to mining Hospitallers massacred	Third *bashura* fell Franks surrendered when they saw Baybars dominated their works	
30 March (16 Sha'ban)	Breaches made in a tower and citadel taken by storm Artillery (possibly two engines) moved into the citadel to assail the keep			
7 April (24 Sha'ban)	Franks came out of the castle after surrendering			
8 April (25 Sha'ban)				Castle fell

Paul Deschamps understood *bashura* to mean a defensive work ahead of a gate – a barbican in the European sense. Accordingly, he concluded that the Mamluks attacked from the east, moving up the great ramp past its three gates. The last of these gave Baybars access to the inner ward and it was here that he intended to set up his artillery and bombard the three inner southern towers, to which the garrison had withdrawn.[814] D. J. Cathcart King challenged this theory and convincingly argued that the main thrust of the attack came from the south. For King, the triangular outwork to the south of the castle, together with the castle's inner and outer lines of walls, represent the three lines of defences identified by the sources. Accordingly, if the town beyond the castle, which Rey claims was walled,[815] fell on 4/5 March and the outwork was taken on 21 March, the outer wall of the castle would have been that which fell to mining on 29/30 March. It was thus from the inner castle that the Franks agreed to favourable terms of surrender just over a week later.[816] This theory explains why the outer southwest tower, which was undermined on 29/30 March, was rebuilt immediately after the siege and provides a more likely position of strength from which the Franks eventually surrendered.[817]

If the timing provided by the sources is correct,[818] Baybars appears to have initially erected his artillery to the south of the castle to play against the triangular outwork. Lighter engines, and possibly heavier ones, were probably then advanced on to or beside the outwork to support the sappers working against the outer enceinte from 21 March, although this is not mentioned in the sources. Symptomatic of his enthusiastic view of artillery, Kennedy has suggested that artillery was partly responsible for breaching the outer walls and that it was in part the efforts to move these engines inside the outer trace that compelled the defenders of the inner castle to sue for terms.[819] Artillery, however, would have had little effect against the inner castle if it were erected between the castle's two lines of walls, given the limited space and relative elevation of the inner enceinte. A more practical position from which to assail the inner castle would have been the outwork, south of the outer wall.

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[814] Deschamps, *Les Châteaux*, 1:132-34. See also Hillenbrand, *The Crusades*, p. 538, cf. p. 525.

[815] Rey, *Étude sur les monuments*, p. 40.

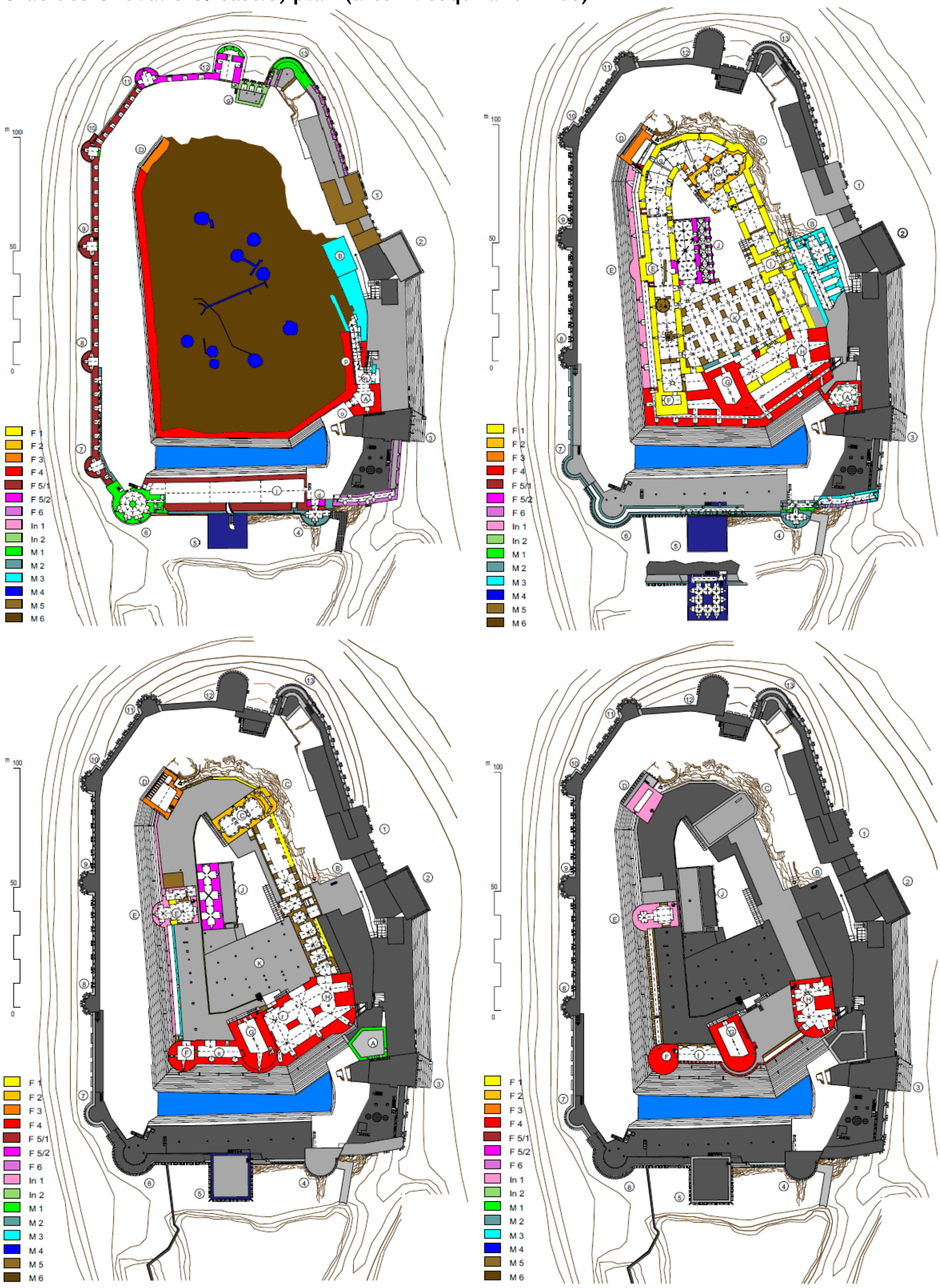
[816] King, "The Taking of Le Krak," pp. 90-92. This theory has stood largely unchallenged, for a slight variant, see Mesqui, "Les programmes architecturaux," pp. 10-11. For Baybars' use of legitimate and forged letters to compel garrisons of the military orders to surrender their strongholds, see the sieges of Beaufort (1268) and Chastel Blanc (1271), Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:642-43, 732; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:110-11, 143.

[817] For different theories of the development of Crac's outer defences, see Mesqui, "Le troisième enceinte"; Biller, et al., *Der Crac des Chevaliers*, pp. 185-253, 263-70; Zimmer, Meyer and Boscardin, *Krak des Chevaliers*.

[818] Peter Thorau has observed that if attention is moved away from Ibn Shaddad and his followers towards Ibn 'Abd al-Zahir and Baybars al-Mansuri, who were present at the siege, the timing of events between the Muslim and Frankish accounts falls closely into line, Thorau, *The Lion of Egypt*, Appendix 5, pp. 265-66.

[819] Kennedy, *Crusader Castles*, pp. 109, 150.

Crac des Chevaliers: castle, plan (after Mesqui and Anus)



The sources do not emphasise the use of artillery during this siege. The Muslim accounts agree generally that it was prepared at some point before 14 March and Ibn 'Abd al-Zahir adds that the Mamluks attempted to bring engines (two according to Ibn al-Furat's subsequent rendition) forward to use against the innermost part of the castle. The

Crac des Chevaliers: castle, from the southern outwork (Denys Pringle)

Crac des Chevaliers: castle, from the west of the southern outwork (Denys Pringle)

Frankish accounts of the siege are less detailed. One version of the *Annales de Terre Sainte* states simply that *enginz* were used in addition to mining.[820] But if Ibn 'Abd al-Zahir's timing of events is correct and notable engines were ready by 14 March (eleven

[820] *Annales de Terre Sainte*, ed. Edbury, p. 160. For a study of this source and its various versions, see Edbury, "Making Sense of the *Annales de Terre Sainte*."

Crac des Chevaliers: projectiles (from Zimmer, Meyer and Boscardin)

days after Ibn Shaddad claims that artillery preparations began), this was twenty-one days after the army had arrived and a week before the outwork was taken. This would have been sufficient time to both erect and employ machines of a significant size.

A number of stones, similar in size to others found inside the castle, have been found southwest of the stronghold and appear to be unused projectiles from 1271. Biller and Burger suggest that this was where Baybars placed his artillery, 250 m from both the triangular outwork and outer southwest tower.[821] But Biller and Burger have assumed that thirteenth-century artillery was capable of ranges up to 500 m, though citing no evidence to support such a claim. Zimmer, Meyer and Boscardin place these stones 300-350 m from the castle and have postulated that Baybars' masons may have shaped projectiles here before they were brought forward to wherever the engines were positioned.[822] There is little evidence to suggest that the

Crac des Chevaliers: castle, plan and topography (after Biller)

[821] Biller, et al., *Der Crac des Chevaliers*, pp. 285-89. See also Biller, et al., "The Crac des Chevaliers," p. 11 fig. 4.
[822] Zimmer, Meyer and Boscardin, *Krak*, p. 285, see also p. 284 figs. 5.70-71; pers. cor. Letizia Boscardin and Werner Meyer, Apr. 2014.

Crac des Chevaliers: castle, from the southwest (Denys Pringle)

projectiles, some weighing around 100 kg, could have been thrown at the castle from the position where they were found with any hopes of hitting it.

None of the sources specifies what Baybars' artillery was targeting but the timing of events suggests that these engines were first used against the timber palisade or such other light defences that probably surrounded the southern outwork. After the outwork had been taken, the Mamluks would most likely have needed to advance these engines in order to bombard the castle itself, possibly placing them near the position where Baybars was said to have established himself with his crossbow. As at Beaufort three years earlier, the castle proper may have been assailed from an outwork that was originally constructed to deny that position to a besieger.

It is hard to imagine stones weighing 100 kg being thrown against the southwest tower at the same time as the sappers, who eventually brought down this tower, were working.[823] It is possible that the two strategies were alternated or that artillery was instead used to target the southern battlements, exposing the castle's defenders. Despite the likelihood that artillery was used against the outer enceinte, there is neither textual nor physical evidence of such: the southern walls were refaced following the siege, removing any blemishes, and no projectiles have been identified in the southern ditch.

[823] This tower appears to sit on the bedrock so it is unlikely that the sappers were working underground, this deprived the protection that naturally accompanied a subterranean tunnel.

Crac des Chevaliers: projectile (from Zimmer, Meyer and Boscardin)

Image protected by copyright

It seems improbable that artillery was erected between the walls of Crac during the last phase of the siege, as alluded to above. Besides the challenges of space and elevation, the components of any engines would need to be moved through the breach and then assembled under fire by the defenders. Perplexingly, a photograph from the early twentieth century displays a large stone between the inner and outer walls at the north end of the castle. This suggests: that the weaker northern wall of the inner castle was besieged from inside the outer enceinte at very close range; that an engine fired at the castle from the northeast; or that at least one stone was subsequently moved here after the siege. The lack of discernible impact signatures and disadvantageous topography northeast of the castle, suggest that this stone may instead be associated with the Mamluk arsenal, although its position is still suspicious. Despite a lack of textual evidence, the large projectiles at Crac suggest that equally large engines were present.

After the siege, Baybars appointed 'Izz al-Din al-Afram, along with 'Izz al-Din Aybak al-Salihi, to repair the castle. These men appear to have had some degree of

Crac des Chevaliers: castle, from the northwest (Denys Pringle)

expertise in this capacity as possession of Crac was granted to a different emir.[824] Because Ibn 'Abd al-Zahir associates 'Izz al-Din al-Afram with Baybars' artillery more than any other emir, it is tempting to suggest that his selection to oversee the castle's repair may have been connected with the increasing power and effective use of such engines. However, no significant trebuchets appear to have been left with al-Afram; instead, the artillery that had been brought to Crac was prepared for transport and, on 29 April, was moved with the army to 'Akkar.

'Akkar: 1271

On the opposite side of the Homs-Tripoli corridor, 'Akkar (Gibelacar) was tucked into the north end of the Lebanon mountains, overlooking the Nahr al-Kabir valley. The site, fortified from the eleventh century, had been acquired by the Franks around the same time as Crac des Chevaliers. The castle was briefly taken by Nur al-Din's forces in the 1160s but thereafter remained under Frankish control.[825]

Baybars is said to have ridden on top of the carts that transported his artillery as they crossed the rough terrain between Crac and 'Akkar. Upon arriving, Baybars determined where to deploy his artillery while masons worked to level the ground, either ahead of the engines as they were brought forward or where they were to be placed. Work began to erect the large trebuchets on 2 May, the same day that a stone from a defensive engine killed a certain emir. On 11 May, the defenders asked for terms, surrendering the following day in exchange for their freedom.[826]

This appears to be the first reference in these sources to artillery being transported by cart, rather than by camels, oxen or hand. Although it could be argued that this was the default means of transportation, it is also the first time that these sources refer to 'large' engines. This, coupled with the ground-levelling ahead of their deployment, indicates that

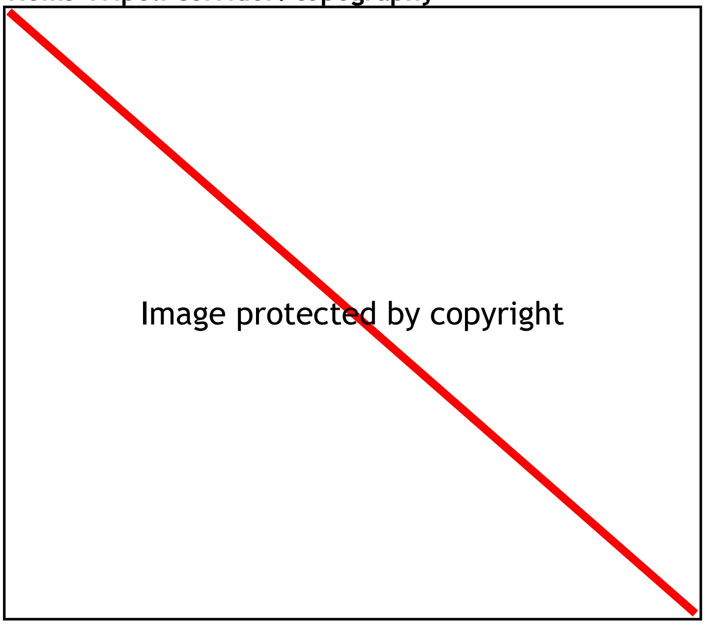
[824] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:745; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:145-46; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:529. For 'Izz al-Din's earlier activities, see Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:554-55, 557, 566, 591; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:69, 71, 76, 91.

[825] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:751-52; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:147-48; Ibn al-Qalanisi, *Dhail*, trans. Gibb, p. 93. For the castle of 'Akkar, see Fournet and Voisin, "Le Château de Aakkar," pp. 149-63; Deschamps, *Les Châteaux*, 3:307-9; Müller-Wiener, *Castles of the Crusaders*, p. 50; Kennedy, *Crusader Castles*, pp. 20, 67-68.

[826] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:748-49; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:148; al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 242. See also Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 153. The martyrdom of Rukn al-Din Mankuwars al-Dawadari in this way, while praying, bears resemblance to that of Badr al-Din al-Aydimuri at Safed in 1266, Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:592.

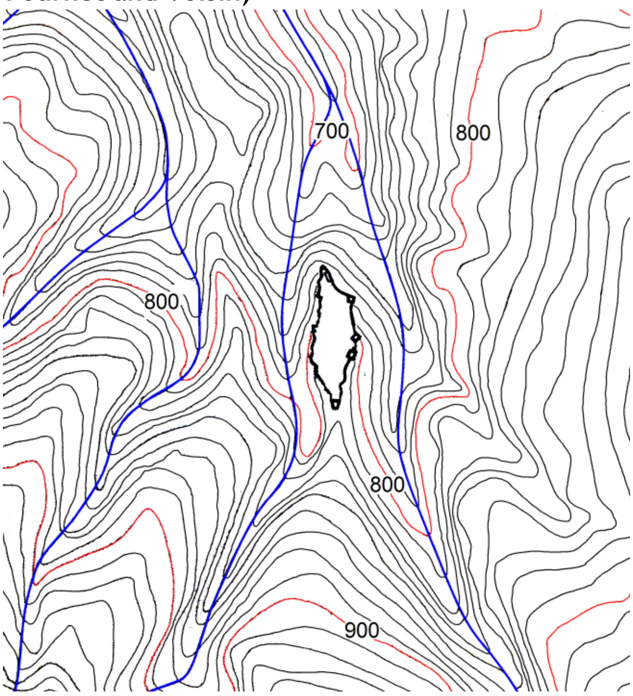
these were significant engines. As no artillery appears to have joined the army during the siege, these would appear to be the same engines that had been used against Crac.

Homs-Tripoli corridor: topography



According to Mufaddal ibn Abi'l-Fada'il, presumably making use of Ibn Shaddad's account, on 10 May the engine that faced the east gate of 'Akkar opened a breach in the wall, which was enlarged by the following morning. In this version of events, this damage and fear of an assault led the garrison to seek terms.[827] The Frankish sources do not mention the Mamluks' use of artillery,[828] but its significance is once again emphasised in a letter sent by Baybars to Bohemond after the siege. Rather than focusing on the scale of the engines directly, it was the difficulties that had been overcome dragging these machines up into the hills that were stressed this time.[829]

'Akkar: castle, plan and topography (after Fournet and Voisin)



Baybars might have planned to continue using these engines in May 1271, but was distracted by Prince Edward of England's arrival in Palestine on 9 May, leading him to withdraw to Damascus. It is unclear whether Baybars left his engines at Crac and 'Akkar or took them with him to Damascus. When he returned to inspect the refortification efforts at

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[827] Mufaddal, *Kitab*, ed. and trans. Blochet, 1:532.

[828] Templar of Tyre, *Gestes des Chiprois* 376, ed. Minervini, pp. 136-38, trans. Crawford, p. 67; *Eracles* 34.14, RHC Oc 2, p. 460.

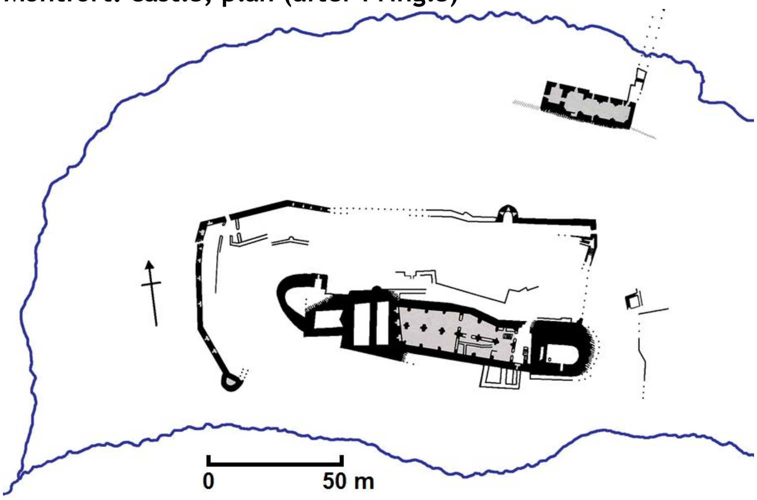
[829] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:749-51.

Crac in 1272, he ordered the catapult stones found outside the castle to be brought inside. Afterwards, he went on to inspect 'Akkar, where he had the defenders fire the engines then within the stronghold, allowing him to examine the range of their projectiles.[830] While this clearly indicates that engines were stored at each in 1272, if they had been there all the while, it is unclear why these arrangements were not made when Baybars visited each in the autumn of 1271.[831] When considering that Baybars stopped at Damascus and Safed after leaving 'Akkar in May 1271, where trebuchets are known to have been stockpiled, it is unclear whether the engines that were used that spring were the same as those used to besiege Montfort in June 1271.

Montfort: 1271

Montfort was the strongest castle of the Teutonic Knights in 1271. Construction had begun in 1226, coinciding with the fortification efforts at Jaffa, Caesarea and Sidon during Frederick II's visit.[832] The castle sits on a spur, about 180 m above Wadi al-Qarn to the north and west, and one of its tributaries to the south.[833] The castle's eastern end is secured by large D-shaped keep and a fosse, with a second ditch about 50 m farther east. The castle was attacked in May 1266 by Badr al-Din al-Aydamuri and Badr al-Din Baysari

Montfort: castle, plan (after Pringle)



[830] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:778.
[831] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:753-54; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:150; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:532-36. For the arrival of Edward of England, see *Annales de Terre Sainte*, ed. Edbury, pp. 160-61; Templar of Tyre, *Gestes des Chiprois* 376, ed. Minervini, p. 138, trans. Crawford, p. 67. For Baybars' visit in late September 1271, see Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:768-69.
[832] *Annales de Terre Sainte*, ed. Edbury, p. 152; letter of Frederick II to Henry III, 17 March 1229, in Roger of Wendover, *Flores historiarum*, ed. Hewlett, 4:189-93, trans. Giles, 2:522-24; *Eracles* 32.25, 33.7, RHC Oc 2, pp. 365, 372. See also Müller-Wiener, *Castles of the Crusaders*, p. 75; Benvenisti, *The Crusaders*, pp. 333-34; Pringle, "A Thirteenth-Century Hall," p. 52; Pringle, *Churches*, 2:40; Kennedy, *Crusader Castles*, p. 129; Mesqui, "La fortification des Croisés," p. 23. Cf. Ehrlich, "Crusaders' Castles," pp. 90-91.
[833] For the castle, see Rey, *Étude sur les monuments*, pp. 143-51; Conder and Kitchener, *Survey of Western Palestine*, 1:186-88; Pringle, "A Thirteenth-Century Hall," pp. 54-55; Pringle, *Secular Buildings*, no. 156, pp. 73-75. Boas, *Crusader Archaeology*, p. 109; Mesqui, "La fortification des Croisés," pp. 10-11. See also Masterman, "A Visit to the Ruined Castles," p. 74.

during Baybars' campaign against Safed; having failed to take it, Ibn 'Abd al-Zahir claims that it posed a threat to Mamluk Safed thereafter.[834]

Baybars, with the force that he had with him at Damascus, moved to Safed in early June 1271. From here, where artillery may have been gathering beforehand, he sent his trebuchets ahead to Montfort. When he arrived in person, Baybars received envoys while he oversaw the erection of these engines, much as he had done at Safed in 1266.

Siege of Montfort, 1271

	Ibn 'Abd al-Zahir and Ibn al-Furat	**Yunini (Ibn Shaddad)**	**Mufaddal**	**al-'Ayni (Baybars al-Mansuri)**	**Templar of Tyre**
5 June (24 Shawwal)	Baybars left Damascus				
6 June (25 Shawwal)		Baybars left Damascus			
9 June (28 Shawwal)		Baybars arrived	Baybars arrived		
11 June (1 Dhu'l-Qa'da)	*Rabad* taken				
12 June (2 Dhu'l-Qa'da)	*Bashura* taken			Castle attacked	Castle taken
23 June (13 Dhu'l-Qa'da)		Garrison surrendered			
3 July (23 Dhu'l-Qa'da)			Garrison surrendered		
4 July (24 Dhu'l-Qa'da)	Destruction complete				
5 July (25 Dhu'l-Qa'da)		Destruction complete			
6 July (26 Dhu'l-Qa'da)			Baybars departed		

Yunini claims that Baybars erected his artillery upon arriving at Montfort but Mufaddal claims that he was initially unable to establish these engines close enough to the castle because of the rough terrain. Ibn 'Abd al-Zahir states that the *rabad* was taken on 11 June, and the *bashura* the following day, corresponding with dates given by Baybars al-Mansuri and the Templar of Tyre. Sapping then commenced and some damage

[834] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:586-87, 756; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:86-87, 151; *Annales de Terre Sainte*, ed. Röhricht and Raynaud, B p. 28 (452).

was apparently inflicted before the garrison agreed to terms. On 13 June,[835] the garrison left the castle for Acre. Baybars made a rapid move against Acre that night, appearing before the city at daybreak the following morning, but returned to Montfort after finding little to be gained. According to Yunini and Mufaddal, Baybars then spent twelve days deconstructing the castle, having spent fifteen days besieging it.[836] Although artillery is given relatively little attention by the sources, the physical evidence provides the first quantitative indication of the power of contemporary trebuchet technology.

Montfort: Dean projectile on display, New York (MET photograph)

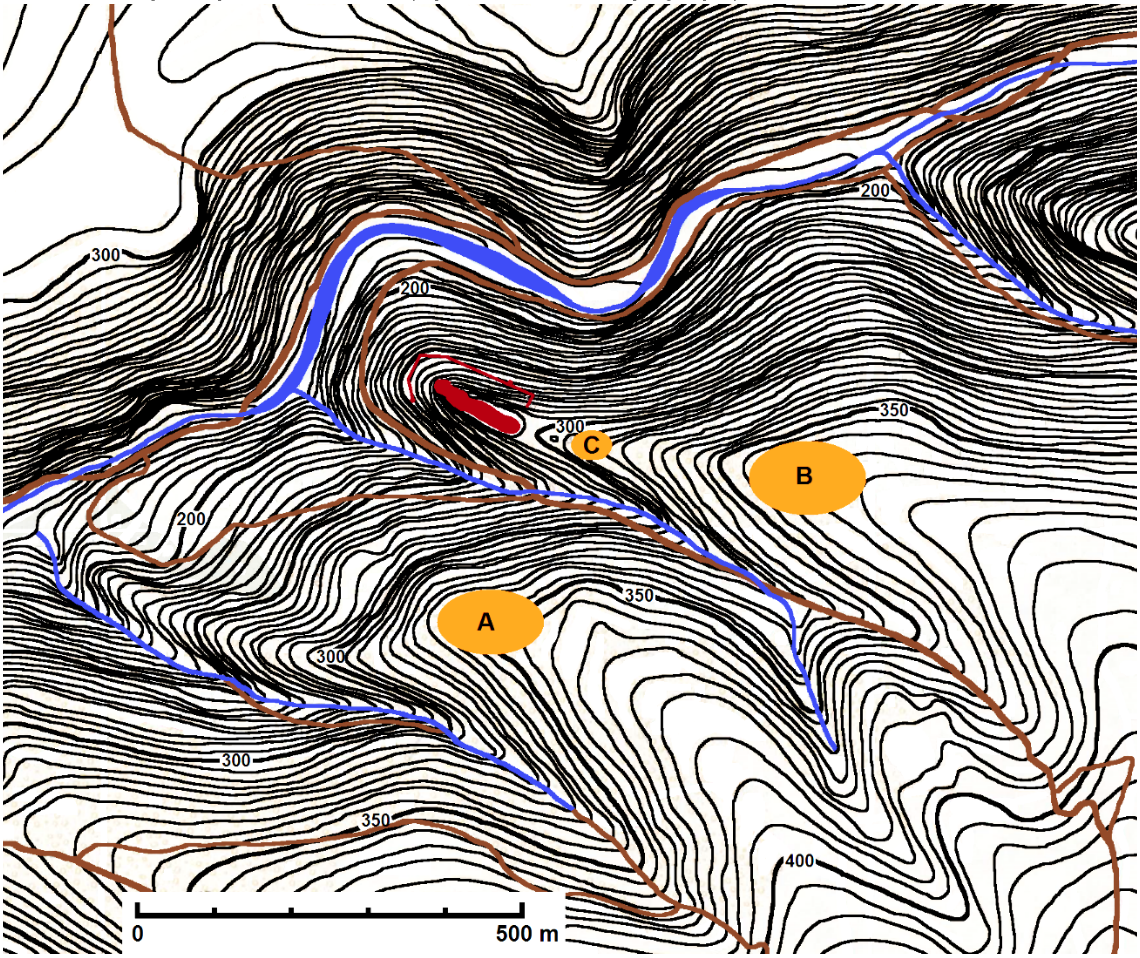
Excavation efforts led by Bashford Dean in 1926, discovered a number of spherical stones that were identified as artillery projectiles. These varied from about 25 cm to 42 cm in diameter, averaging about 32 cm.[837] One of these stones, which was brought back to New York and catalogued by the MET, has a diameter of 32 cm and a mass of 66 kg. Another, discovered *in situ* in 2013, was found to have a mass half as great.[838]

Montfort: 2013 projectile *in situ* (author)

The topography around Montfort limits the potential positions where attacking artillery may have been positioned. The spur to the east of the castle is fairly rough. Aside from a small position

[835] Mufaddal appears to misdate this by ten days, in the same way that Yunini, or Ibn Shaddad, probably misdated Baybars' arrival at Crac des Chevaliers.
[836] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:755-57; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:151; Yunini, trans. Khamisy in "Montfort Castle"; al-Mansuri, trans. Khamisy in "Montfort Castle"; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:539-43; al-'Ayni, *'Iqd al-Juman*, RHC Or 2a, p. 244, trans. Gabrieli in *Arab Historians*, p. 320; Templar of Tyre, *Gestes des Chiprois* 378, ed. Minervini, p. 138, trans. Crawford, p. 67. See also Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 153; *Eracles* 34.14, RHC Oc 2, p. 460.
[837] Dean, "The Exploration of a Crusaders' Fortress," pp. 12, 23, 38.
[838] My thanks to Donald LaRocca at the MET for confirming the weight of this stone and to Adrian Boas and Rabei Khamisy for allowing me to weight the 2013 stone.

Montfort region: possible artillery positions and topography



about 80 m from the castle (area C on the map), there does not appear to have been a significant natural or artificially levelled position within 300 m of the castle. This might reflect Mufaddal's observation that the rough terrain initially prevented Baybars from positioning his artillery close enough to the castle. The only other position appears to be on the ridge across the southern wadi (area A on the map), approximately 220 m from the castle but around 30 m higher than the foundations of the keep.[839]

A release velocity of at least 45 m/s would have been necessary to carry a projectile across the southern wadi. Although such release velocities might have been achieved with smaller projectiles by the end of the twelfth century and the stones found at Crac demonstrate that stones of the size of those found in Montfort had been used earlier in 1271, this is the first instance of evidence that stones this large may have been thrown at such speeds. Accordingly, this appears to be the earliest quantifiable evidence of the power of medieval artillery: an engine capable of throwing a 60 kg projectile at 45

[839] Rabei Khamisy and Rafi Lewis have identified what they believe to be artillery projectiles in this position, pers. cor. Aug 2015.

Montfort: castle, from area C (author)

m/s transfers 60,750 J to the projectile during a firing sequence. In terms of scale, the engine would probably require a counterweight greater than 3,000 kg and a beam around 8 m long.[840]

The closest target to an engine positioned in area C would have been the keep. Built to defend the face of the castle most exposed to attack, the keep would have been a significant obstacle. Its walls are around 7 m thick, although there is evidence of internal passages in sections, and faced with hard limestone ashlars so large that Dean concluded that they had been cut in antiquity and which Yunini and Mufaddal claim were linked with iron cramps welded with lead.[841] Projectiles weighing 100 kg would have posed little threat to such strong masonry. Although it cannot be concluded with any certainty that the keep was strong enough to discourage the Mamluks from bombarding it,[842] and its destruction may have buried the projectiles thrown at it, it is possible that the weaker buildings to the west were deliberately targeted instead.

The projectiles found by Dean were concentrated to the west of the keep, between it and the central vaulted structure, and in the latter structure at its west end. From area C, a single engine, as there does not appear to have been space for a second, could have fired

[840] For hypothetical data sets, see Appendix 3.
[841] Dean, "The Exploration of a Crusaders' Fortress," p. 6; Mufaddal, *Kitab*, ed. and trans. Blochet, 1:542; Yunini, trans. Khamisy in "Montfort Castle."
[842] It is possible that the destruction of the keep buried projectiles that were thrown at this part of the castle during the siege.

Montfort: castle, from area A (author)

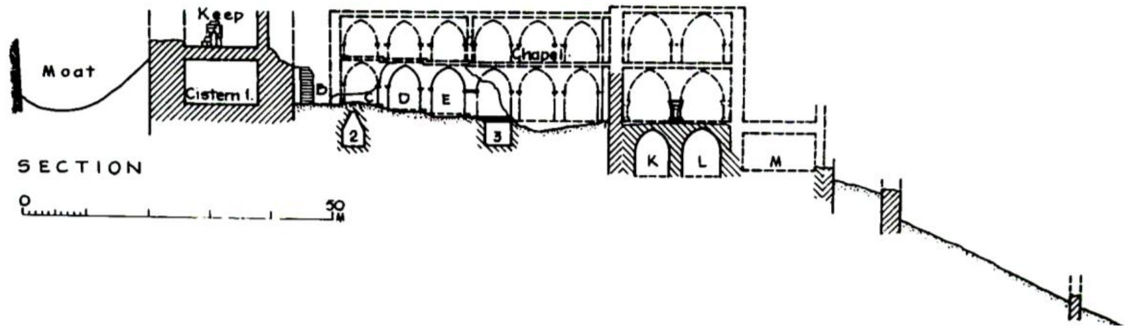
stones to both locations as the slight curve of the spur would have exposed the northern face of the castle and sections west of the keep. While area C would have been the closest place to erect a sizable engine, it is possible that the castle was also bombarded from the ridge to the south, where Baybars appears to have positioned his headquarters.[843] Although the steep topography would have limited the value of any breach opened in the castle's southern curtain, the psychological impact of such large stones being thrown against, and perhaps into, the weaker parts of the castle was probably significant.

The comparative weakness of the castle's southern walls, less than 1 m thick in places, suggests that they were considered to be beyond the range of any significant artillery when they were constructed. That this front of the castle was not subsequently strengthened, despite evidence that construction continued through the 1260s,[844] indicates either that the power of these engines was not appreciated by those responsible for fortifying the castle, suggesting that such engines had not been developed or effectively employed until very recently, or that such engines were still not considered to be a threat.

The projectiles found by Dean appear to be too large for a practical defensive function: there are few advantages to throwing a stone 60 kg compared to throwing one a third as large with the same amount of force when targeting men, siege engines or improvised defences. When adding to this the lack of space for an engine of the necessary

[843] Khamisy, "Montfort Castle."
[844] Pers. cor. Adrian Boas, May 2013, Aug. 2015.

Montfort: castle, section (from Pringle)



proportions, the suggestion that these projectiles might have been part of a defensive stockpile can be all but discarded. The keep may have been able to support a single eastward-facing engine, but the value of such an engine relative to the space it denied other means of defence appears unjustifiable. The structure of the vaulted ranges in the middle of the castle and the great hall to the west would appear to have been incapable of supporting the dynamic forces created by a counterweight trebuchet. Although the stones may have been part an offensive stockpile, their positioning is hard to explain.

There are few other insights into the use of artillery before Baybars' death in 1277. Edward of England and Henry of Cyprus do not appear to have used any siege equipment when they attacked Qaqun in 1271,[845] and there are few indications that Baybars employed siege engines during his successful siege of Cursat in 1275.[846] A decade later, however, engines larger than those used by Baybars appear to have been employed by his successor.

The Sultanate of Qalawun

Margat: 1285

Margat was acquired by the Hospitallers in 1186 and, like Crac des Chevaliers, was bypassed by Saladin as he moved his army up the Syrian coast in 1188.[847] The castle's

[845] Templar of Tyre, *Gestes des Chiprois* 381, ed. Minervini, p. 140, trans. Crawford, p. 68; *Eracles* 34.14, RHC Oc 2, p. 461; Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:770-71. For the structure, see Pringle, *Secular Buildings*, no. 168, pp. 83-84.
[846] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:831-33; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:165. For this castle, see Deschamps, *Les Châteaux*, 2:351-57; Boase, "Military Architecture," pp. 162-53; Kennedy, *Crusader Castles*, p. 84.
[847] Caffaro states that the castle was built before the Franks arrived in the Levant. It fell to them in 1140 after a surprise attack, Caffaro, *De liberatione*, ed. Belgrano, pp. 115-16, trans. Hall and Phillips, p. 119. For the castle's ability to apply pressure to Saladin's army as it passed, see 'Imad al-Din, *al-Fath*, trans.

Margat: castle, from the south (Denys Pringle)

double line of walls also impressed Wilbrand of Oldenburg when he passed by in the early thirteenth century.[848] Baybars had made two abortive attacks on Margat during the harsh winter rains of January 1270, apparently travelling without siege equipment on both occasions.[849] Another Mamluk attack was made in 1280/81, but this was routed in a sally by the garrison.[850]

In 1285, Qalawun summoned arms from Egypt and enlisted a number of siege experts before setting out from Damascus to besiege the castle. The artillery stored in Damascus, as well as that requisitioned from the surrounding strongholds, was carried on men's shoulders to his camp at 'Uyun al-Qasab before the army travelled by forced marches to Margat, arriving on 17 April. Ibn 'Abd al-Zahir specifies that "three of the great 'Frankish' type, three 'Qarabughas' and four 'devils' [Shaytania]" were deployed against the castle, while Abu'l-Fida' similarly claims that both great and small engines were erected. The 'Frankish' engines are noted to have destroyed the artillery of the

Massé pp. 125-26; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:345. Isaac Comnenus was imprisoned here in 1191, Roger of Howden, *Chronica*, ed. Stubbs, 3:116, trans. Riley, 2:210. See also Ralph of Diceto, *Ymagines historiarum*, ed. Stubbs, p. 92.

848 Wilbrand of Oldenburg, *Itinerarium terrae sanctae* 1.11, ed. Pringle, pp. 121-22, trans. Pringle, pp. 69-70. For the castle and its history, see Rey, *Étude sur les monuments*, pp. 19-38, 255-64; Deschamps, *Les Châteaux*, 3:259-85; Müller-Wiener, *Castles of the Crusaders*, p. 58; Kennedy, *Crusader Castles*, pp. 78-79, 164-79. Mesqui, "La fortification des Croisés," pp. 22-23.

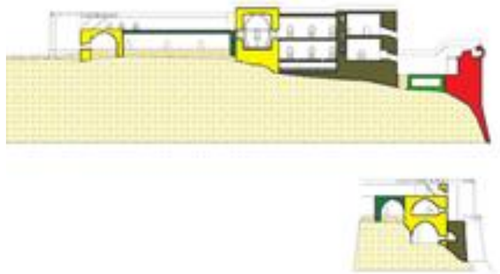
849 Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:729; Ibn 'Abd al-Zahir, *Tashrif al-Malik al-Mansur*, trans. Gabrieli in *Arab Historians*, p. 334; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:139, 141. See also Thorau, *The Lion of Egypt*, pp. 200-1.

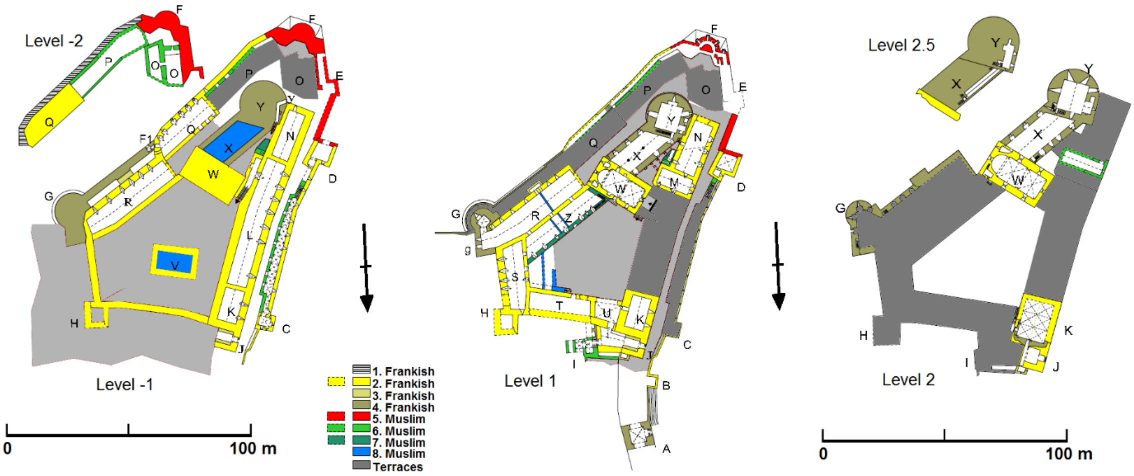
850 Abu'l-Fida', *al-Mukhtasar*, RHC Or 1, p. 158; Templar of Tyre, *Gestes des Chiprois* 406, ed. Minervini, p. 154, trans. Crawford, p. 77; *Annales de Terre Sainte*, ed. Röhricht and Raynaud, A p. 33 (457); Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 2:463.

defenders, allowing the Muslims to advance their artillery closer to the walls. This move proved slightly reckless as the Franks were able to repair their engines, which then destroyed a number of the Muslims' trebuchets and killed some of their operators.[851] Amidst the artillery duel, Muslim sappers worked against the castle's foundations.

After about three weeks, a mine was fired under a tower at the southern apex of the castle, identified as the Tower of Hope by the Templar of Tyre. The mine compromised a section of wall but the attackers were still forced to scale the obstruction. The advantage was short-lived: the remaining part of the tower collapsed around sunset, somehow shoring up the initial breach. The Franks, fearing the progress of the Mamluk miners elsewhere, sought terms a day or two later. Qalawun seized the opportunity to take possession of the castle without damaging it any further.[852] Among the 550 men that were designated to defend the castle thereafter, was a group of artillery experts, suggesting that at least some of the engines used against the castle, and any left in a state of repair by the garrison, became a part of its arsenal.

Margat: castle, section and plan (after Mesqui)





[851] Ibn 'Abd al-Zahir, *Tashrif al-Malik al-Mansur*, trans. Gabrieli in *Arab Historians*, pp. 334-35; Abu'l-Fida', *al-Mukhtasar*, trans. Holt, p. 12, RHC Or 1, p. 161.

[852] Ibn 'Abd al-Zahir, *Tashrif al-Malik al-Mansur*, trans. Gabrieli in *Arab Historians*, pp. 335-38; Abu'l-Fida', *al-Mukhtasar*, trans. Holt, p. 12; Templar of Tyre, *Gestes des Chiprois* 429, ed. Minervini, p. 166, trans. Crawford, p. 85; Marino Sanudo, *Liber secretorum* 3.12.19, ed. Bongars, p. 229, trans. Lock, p. 364. 'Ibn 'Abd al-Zahir appears to date the mine to Wednesday 17 Rabi I but the castle's fall to Friday 18 Rabi I; the week will be taken as correct, bringing this account in line with that of Abu'l-Fida.

Siege of Margat, 1285

	Ibn 'Abd al-Zahir	**Abu'l-Fida'**	**Templar of Tyre**	**Marino Sanudo**
17 April (10 Safar)	Qalawun arrived		Siege began	
27 April (20 Safar)				Siege began
23 May (17 Rabi I)	Mine fired			
25 May (19 Rabi I)	Castle surrendered	Castle surrendered		
27 May (21 Rabi I)			Castle surrendered	Castle surrendered

The descriptions of artillery at Margat are enlightening. On one hand Qalawun used his engines to cover his miners and target the defenders' artillery, tactics that had been employed since the First Crusade. On the other, they appear to have been advanced closer to the walls in an attempt to effect structural damage, similar strategies to those which may have been attempted at Acre in 1191 and Crac des Chevaliers in 1271.

Margat: donjon, impact signatures (Balázs Major)

Images omitted

Although the rebuilding of the outer wall around the castle's southern apex has obscured any effects that Qalawun's artillery had here, impact signatures created by higher trajectory shots are discernible along the southern face of the donjon, which rises behind this wall. The relatively small number of these markings indicates that equally few shots hit the donjon, probably because they were fired by engines with a slow rate of fire. Despite the apparent power necessary to leave such impressions in the basalt masonry, when viewed from afar, these appear to be little more than cosmetic blemishes, especially when compared to the fissures created by later earthquakes. Besides the large slow-firing engine that created these impact signatures, the sources clearly indicate that smaller engines were also employed, even if it is difficult to discern what differentiated the various types listed from one another.

Qalawun had inherited Baybars' network of armouries and by the time that he set out for Margat he was able to summon experts in addition to engines. Following its capture, Margat was incorporated into this network, as Safed had been in 1266.[853] While the impact signatures at Margat impress the relative power of late thirteenth-century artillery, its range is evident in Ibn 'Abd al-Zahir's account of events at Maraclea soon afterwards.

Maraclea: 1285

The stronghold of Maraclea (Maraqiyya) was situated on an offshore island, facing the settlement of the same name, and appears to have been refortified in the decade leading up to 1285.[854] Ibn 'Abd al-Zahir claims that the stronghold had sides 25.5 cubits long and was two bow-shots from the mainland. Modern satellite imagery shows a square structure, with sides about 15 m long, just under the surface of the water on a shoal about 190 m off the present coast of Syria. Although this appears to match Ibn 'Abd al-Zahir's general description, it is harder to verify his claims that the walls were 7 cubits thick (a reasonable thickness), that the tower was built on piles of stones held in place by ironwork, and that it was seven storeys tall. Critically, he states that the roof was covered with sacking and hemp rope, as a defence against artillery, and that a smaller structure behind the main one supported three defensive trebuchets.[855]

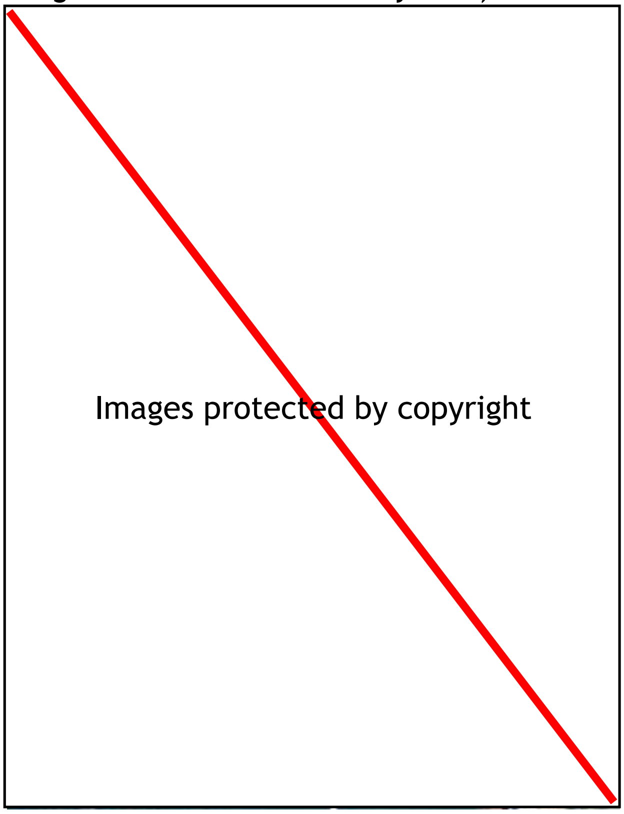
Despite the suggestions that the structure was within range of contemporary artillery, Qalawun recognised that he could not take the strongpoint without a naval force superior to that of the Franks, which he did not have. Rather than bombard the fortress needlessly, he persuaded Bohemond VII to destroy it, sparing the Frankish lands around Tripoli from raids in return.[856]

The castle's padded roof indicates that it was vulnerable to high-trajectory artillery fire; however, that this was also sufficient to absorb the shock of an impact at this range is equally telling. When placed alongside the earlier events at Montfort and Margat, a fairly clear impression of late-thirteenth-century artillery becomes apparent. At least the

[853] See Fulton, "Development of Prefabricated Artillery," pp. 65-70.
[854] For this castle, see Deschamps, *Les Châteaux*, 3:323-26; Rey, *Étude sur les monuments*, pp. 161-62.
[855] Ibn 'Abd al-Zahir, *Tashrif al-Malik al-Mansur*, trans. Gabrieli in *Arab Historians*, p. 339.
[856] Ibn 'Abd al-Zahir, *Tashrif al-Malik al-Mansur*, trans. Gabrieli in *Arab Historians*, pp. 340-41.

largest engines were capable of throwing stones about 60 kg up to 200 m. The effect of these projectiles, however, was not significant by modern standards. Rather than seeking to breach fortified defences, against which they could inflict little more than superficial damage, they were probably used to target the battlements and expose the defenders of approachable strongholds, such as Crac and Margat, or as a psychological weapon, causing indiscriminate death and chaos behind the walls of more isolated castles such as Montfort.

Maraclea: castle foundations (Google Earth, images of 1 Nov 2014 and 5 May 2010)



While Qalawun may have hoped to exploit the power of his engines by moving them forward at Margat, this may have been accomplished with greater success at Saone, when the castle was besieged in 1287. As has been mentioned above, if artillery inflicted the significant damage evident at the north end of the outer eastern wall, it more likely occurred at this point in history. Although Ibn 'Abd al-Zahir mentions the use of a number of signficant trebuchets at this siege, it is just as likely that the damage was the result of an earthquake.[857]

Tripoli: 1289

The trace of Tripoli's defences at the end of the thirteenth century is unclear. At the start of the century, Wilbrand of Oldenburg compared the city's layout to Tyre's, complete with a citadel complex and two lines of town walls. Abu'l-Fida' confirms that the city was protected by its extension into the Mediterranean and that it was only along a narrow eastern front that the Mamluks could assail it.[858]

[857] My thanks to Rabei Khamisy for translating this section of Ibn 'Abd al-Zahir's account, as a translation has not yet been published. For this siege, see also Abu'l-Fida', *al-Mukhtasar*, trans. Holt, p. 13, RHC Or 1, p. 162; Templar of Tyre, *Gestes des Chiprois* 461-62, ed. Minervini, p. 186, trans. Crawford, pp. 94-95. For an analysis of the damage, see Fulton, "A Ridge too Far."

[858] Wilbrand of Oldenburg, *Itinerarium terrae sanctae* 1.8, ed. Pringle, p. 120, trans. Pringle, p. 67; Abu'l-Fida', *al-Mukhtasar*, trans. Holt, p. 14. See also Müller-Wiener, *Castles of the Crusaders*, p. 42.

The siege of Tripoli began at some point in March 1289. Although it is not mentioned by the sources, Qalawun probably sent orders for the artillery stored in Syria to be prepared as he marched out of Egypt, possibly having these engines brought together around Damascus, where he paused on his way to Tripoli, as he had in 1285. Regardless, an assortment of trebuchets were firing against Tripoli by early April. The engines appear to have focused their fire against the Bishop's Tower and that of the Hospitallers, while sappers attempted to undermine the town's defences. The outer enceinte was taken first and then a single concerted attack carried the inner line around 26 April 1289.[859]

Abu'l-Fida' and the Templar of Tyre claim that Qalawun employed both large and small trebuchets. Al-Maqrizi, probably working from Ibn al-Furat – who in turn made use of Ibn al-Dawadari and al-Yunini – claims that Qalawun employed nineteen trebuchets, associating 1,500 men with their operation (seventy-nine men to each engine if evenly distributed).[860] While six of the nineteen trebuchets are said to have been of the 'Frankish' type, which probably correspond with the four large engines identified in one version of the *Annales de Terre Sainte*, the majority were lighter machines. The thirteen *qarabugha* engines found in certain Muslim accounts, corresponding with the *carabohas* mentioned by the Templar of Tyre, were almost certainly traction trebuchets.[861] As at Arsuf twenty-four years earlier, increasingly heavy artillery was still outnumbered by lighter, more adaptable engines that could support sapping efforts. The Templar of Tyre clearly distinguishes the ways in which the heavy engines and archers were used: the former battered and damaged the two targeted towers while the latter were used against the Frankish crossbowmen. The city's complete destruction following the siege has rendered it impossible to assess the degree of damage inflicted by these engines during the two months that they were in action.[862]

[859] Abu'l-Fida', *al-Mukhtasar*, trans. Holt, pp. 14-15, RHC Or 1, p. 162; Templar of Tyre, *Gestes des Chiprois* 475-77, ed. Minervini, p. 196, trans. Crawford, pp. 100-1; Marino Sanudo, *Liber secretorum* 3.12.20, ed. Bongars, p. 229, trans. Lock, p. 365; al-Maqrizi, *al-Suluk*, trans. Quatremère, 2:102-3; *Annales de Terre Sainte*, ed. Röhricht and Raynaud, A p. 36 (460). See also Marshall, *Warfare in the Latin East*, p. 218. Marino Sanudo blends the earlier campaign against Saone and Latakia with that against Tripoli, claiming that Qalawun had engines prepared at Crac on his way to the latter.

[860] If anywhere near accurate, not everyone counted in this total would have been directly involved with the working of these engines at any one time. See the comparable figure suggested at Lisbon in 1147 and associated analysis in Chapter 4.

[861] For a short evaluation of this term, see Appendix 1.

[862] The city was resettled farther inland around the castle founded by Raymond of St Gilles soon after, see Ibn Battuta, *Tuhfat* 1.1, trans. Gibb, p. 60; Müller-Wiener, *Castles of the Crusaders*, p. 42.

The Second Great Siege of Acre: 1291

A peace that had been established between the Franks of Acre and Qalawun was violated in 1290, giving Qalawun the opportunity to move against Acre.[863] The sultan, however, died in November while setting out once more from Cairo for Palestine. Before his death, Qalawun had arranged for the governor of Damascus to build siege equipment, including artillery, and for Shams al-Din al-A'sar al-Mushidd to collect timber from Wadi Murabbin, a valley between 'Akkar and Baalbek where trees ideal for the construction of trebuchets grew – stout, straight and as tall as twenty-one cubits according to al-Nuwayri. Although the latter emir's efforts were complicated by an early snowfall, Yunini claims that he was able to move a number of trees to the outskirts of Damascus by 23 December 1290.[864]

Qalawun was succeeded by his son al-Ashraf Khalil, who set out for Palestine, with siege engines and technicians to assemble them, in March 1291. 'Izz al-Din Afram, possibly the same who had received acclaim for handling artillery under Baybars, was sent ahead to see to the artillery in Damascus. He was met there by the princes and emirs of Syria, along with their artillery and armies. There can be little doubt that the largest prefabricated engines were brought, as one engine, a 'great' trebuchet collected by the prince of Hama from Crac des Chevaliers, supposedly required a hundred cartloads. The forces gathered at Damascus then moved to join those that had begun to assemble outside Acre.[865]

Artillery and the Siege

Their are numerous accounts of the siege of Acre, which have been discussed and analysed by Donald Little and Andreas D'Souza.[866] According to Sayf al-Din, an eyewitness of the siege, seventy-two trebuchets were set up against Acre, including those of the *Ifranji*, *Shaytani*, *Qarabugha*, and *al-La'ib* types. Al-'Ayni gives the same figure of

[863] For this treaty and its violation, see Holt, "Qalawun's Treaty," pp. 802-12.
[864] Little, "The Fall of 'Akka," pp. 167-68. See also Abu'l-Fida', *al-Mukhtasar*, trans. Holt, p. 15.
[865] Ibn Taghribirdi, trans. Gabrieli in *Arab Historians*, p. 347; al-Maqrizi, *al-Suluk*, trans. Quatremère, 2:121-24; Abu'l-Fida', *al-Mukhtasar*, trans. Holt, p. 16; Little, "The Fall of 'Akka," pp. 168-71; D'Souza, "The Conquest of 'Akka," p. 239. Abu'l-Fida' vividly describes the difficulties of moving the cart assigned to him in the harsh winter conditions.
[866] Little, "The Fall of 'Akka," pp. 159-81; D'Souza, "The Conquest of 'Akka," pp. 234-50.

Acre: town and deployment of Mamluks in 1291, plan (adapted from Kedar and Folda)

seventy-two engines and specifies that fifty-two were of the *Shaytani* type. Yunini and Ibn Taghribirdi distinguish fifteen large 'Frankish' trebuchets, capable of throwing stones weighing a Damascene *qintar* or more, in addition to engines of other types. Al-Maqrizi gives the slightly larger figure of ninety-two engines.[867]

From the Frankish perspective, the Templar of Tyre claims that these engines were erected eight days after the first Muslim forces arrived. The Amadi account states that it took four days for the Muslims to prepare their siege engines, a similar period to that found in most of the Muslim accounts. In line with the figure provided by Yunini and Ibn Taghribirdi, the *Annales de Terre Sainte* states that fourteen large engines were used, while the Templar of Tyre repeats that some engines threw stones weighing a *qintar*. According to the latter source, one notable engine was positioned opposite the Templars' section of Acre's defences, another opposite the Hospitallers' section, a third targeted the Accursed Tower and a fourth opposed the Pisans' section. This last engine was called al-Mansur, the same name as that given by Abu'l-Fida' to the engine brought from Crac des

[867] Ibn Taghribirdi, trans. Gabrieli in *Arab Historians*, p. 347; Little, "The Fall of 'Akka," p. 171 and n. 72; D'Souza, "The Conquest of 'Akka," p. 252; al-Maqrizi, *al-Suluk*, trans. Quatremère 2:125.

Chevaliers, suggesting that these were commissioned by Qalawun after 1277.[868] In addition to these large engines, the Templar of Tyre, John of Villiers, grand master of the Hospitallers, Marino Sanudo and the Amadi account all confirm the presence of *carabouha*/*corobonares*/*carabagas*/*caravachani*, which are also mentioned by some of the Muslim sources. The Templar of Tyre describes these as rapid-firing hand-operated stone-throwers that posed a greater threat to Acre's defenders than did the larger engines; however, John of Villiers and Marino Sanudo, who do not contradict this description, portray them as being somewhat more powerful.[869] These, as noted above, were probably traction trebuchets: heavier than the hand-slings but lighter than the counterweight trebuchets.[870]

Other Christian sources are less helpful. The *Excidium* states that six hundred and sixty-six large and small engines were used, including *petrarie*, *bibliete*, *perdicete* and *mangonelli*. Three hundred engines are mentioned in the account of Bar Hebraeus, as unlikely as his claim that a thousand miners worked against each tower. Ludolph of Suchem places the number of engines at a more reasonable sixty but provides no further details.[871]

With the Muslim forces assembling against them, the Franks prepared their own artillery and gathered stones.[872] Some of these engines may have been those built under Odo Poilechien, on behalf of Charles of Anjou, in 1286, originally intended for use against Henry II of Cyprus.[873]

Attacks appear to have begun on 5 April, although artillery continued to arrive until 8 April. The gates of Acre remained open during this early phase as fighting took place outside the city's walls. The Muslims, fighting in shifts, eventually pushed their way

[868] It is possible that these engines were one and the same; however, the engine brought from Crac would not have been that which was operated by the contingent from Hama, as they were positioned on the Muslims' extreme right, opposite the Templars, while the Pisans were positioned close to the Accursed Tower, which anchored Acre's northeast salient.

[869] *Annales de Terre Sainte*, ed. Röhricht and Raynaud, A pp. 36-37 (460-61); Templar of Tyre, *Gestes des Chiprois* 490-91, ed. Minervini, pp. 206-8, trans. Crawford, pp. 105-6; letter of John of Villiers to William of Villaret, in *Carticulaire général des Hospitaliers*, no. 4157, 3:593; Marino Sanudo, *Liber secretorum* 3.12.21, ed. Bongars, p. 230, trans. Lock, p. 367; *Amadi*, ed. De Mas Latrie, pp. 219-20.

[870] For different interpretations, see Chevedden, "Black Camels," pp. 251-54; Marshall, *Warfare in the Latin East*, pp. 214, 234. For the staff-sling, see Appendix 1.

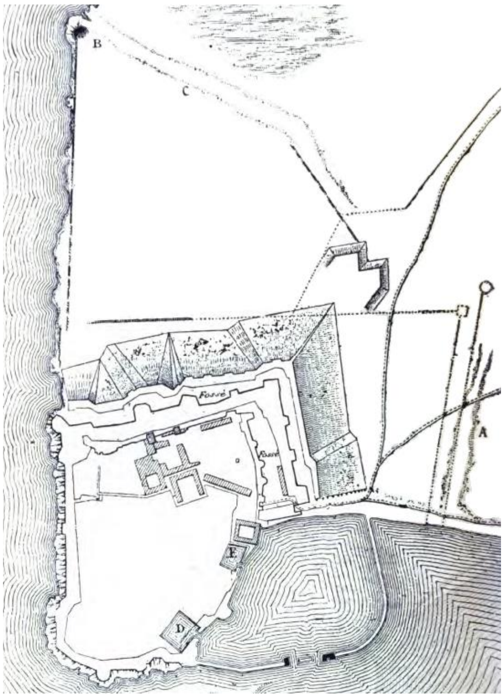
[871] *Excidium Aconis* 2.3, ll. 123-48, ed. Huygens, pp. 67-68; Bar Hebraeus, *Makhtebhanuth Zabhne*, trans. Budge, 2:492-93; Ludolph of Suchem, *De itinere Terrae sanctae liber* 26, ed. Deycks, p. 43, trans. Stewart, p. 56.

[872] Templar of Tyre, *Gestes des Chiprois* 485, ed. Minervini, p. 204, trans. Crawford, p. 104; letter of John of Villiers to William of Villaret, in *Carticulaire général des Hospitaliers,* no. 4157, 3:593; *Excidium Aconis* 1.8, ll. 327-34, ed. Huygens, pp. 60-61.

[873] Templar of Tyre, *Gestes des Chiprois* 437-38, ed. Minervini, pp. 168-70, trans. Crawford, p. 86.

to the edge of the fosse. Here, they erected mantlets at the edge of the counterscarp and developed positions behind which the *carabouhas* could be placed securely. These traction engines provided close suppressing fire while heavier engines battered the city's fortifications, probably targeting the battlements initially, and sappers began to undermine certain sections of wall.[874] The Frankish engines had little effect on the Muslims' improvised ramparts; however, a ship-mounted trebuchet applied pressure against the Muslims' right flank, until it was destroyed during a storm.[875] It may have been the artillery here on the Muslims' extreme right, that of the contingent of Hama, which was targeted in a subsequent sally led by the Templars.[876]

Acre: nineteenth-century town, plan (from Rey)

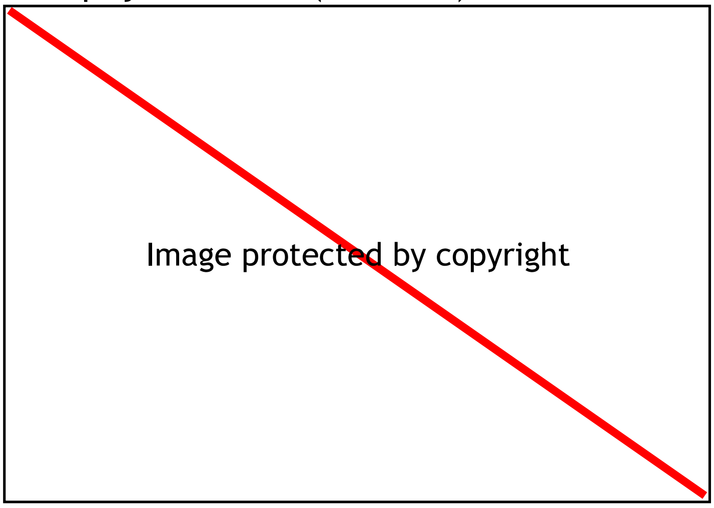


In the mid-twentieth century, about fifty medieval artillery projectiles were found around what had been the northwest limit of Acre's defences.[877] These probably relate to projectiles excavated *in situ* roughly 100-200 m north of these and the same distance from the present coastline.[878] Together, these represent where the engine(s) of the contingent of Hama was/were placed and where those that were thrown against the Templars' section of the city's defences ultimately came to rest. Both the mass of these stones and the implicit distance over which they were fired

[874] Abu'l-Fida', *al-Mukhtasar*, trans. Holt, pp. 16-17; Templar of Tyre, *Gestes des Chiprois* 489, 491, ed. Minervini, pp. 206, 208-10, trans. Crawford, pp. 105, 106-7; letter of John of Villiers to William of Villaret, in *Carticulaire général des Hospitaliers*, no. 4157, 3:593; Thadeus, *Ystoria* ll. 48-60, ed. Huygens, p. 101; Marino Sanudo, *Liber secretorum* 3.12.21, ed. Bongars, p. 230, trans. Lock, p. 367; *Amadi*, ed. De Mas Latrie, p. 220; Ludolph of Suchem, *De itinere Terrae sanctae liber* 26, ed. Deycks, p. 43, trans. Stewart, p. 56; D'Souza, "The Conquest of 'Akka," p. 241.
[875] Abu'l-Fida', *al-Mukhtasar*, trans. Holt, pp. 16-17; Templar of Tyre, *Gestes des Chiprois* 491, ed. Minervini, p. 208, trans. Crawford, p. 106.
[876] Templar of Tyre, *Gestes des Chiprois* 491, ed. Minervini, pp. 208-10, trans. Crawford, pp. 107-8. Cf. Abu'l-Fida', *al-Mukhtasar*, trans. Holt, p. 17; *Amadi*, ed. De Mas Latrie, pp. 220-21. See also Templar of Tyre, *Gestes des Chiprois* 492, ed. Minervini, p. 210, trans. Crawford, p. 108; *Amadi*, ed. De Mas Latrie, p. 221.
[877] For the trace of Acre's thirteenth-century walls, see Guérin, *Description*, 3:507; Rey, *Les colonies Franques*, pp. 452-54; Kedar, "The Outer Walls," p. 161. See also Frankel, "The North-West Corner," p. 256. Cf. Jacoby, "Crusader Acre," p. 42 and n. 214; Jacoby, "Montmusard," p. 215. For the development of this trace, see Jacoby, "Montmusard," pp. 205-17.
[878] Porat, "'Akko, Dov Gruner Street."

conform to trends that had been established over the previous thirty years. Similar engines appear to have been erected to the east of the city.

Acre: projectiles *in situ* (from Porat)



Large projectiles were discovered around a wall that was exposed in the 1970s. Kedar has identified this as part of the city's medieval wall, near the St Nicholas gate. Additional projectiles can be found in the present Christian cemetery to the east of where the city's northeast salient would have been in the thirteenth-century.[879] These, approximately 100 m from the medieval curtain and of varying sizes, suggest that at least one large engine, as well as smaller ones, was placed in this general area.

As in 1191, mining efforts focused on the northeast salient of the city. As the Muslims attempted to undermine the King's Tower, which anchored the forewall ahead of the Accursed Tower,[880] their *carabouhas* were critical in providing cover for the sappers and forcing the Franks to countermine.[881] A portion of Acre's outer wall was successfully undermined by the time that Henry II of Cyprus arrived on 4 May and by 8 May the Franks abandoned the outer wall in this section. While the Franks added improvised defences to face this exposed salient the Muslims stepped up their bombardment of the town's defenders.[882]

On 15 May, the King's Tower was abandoned, its outer face having fallen away completely. As the besiegers moved into the tower, it was then targeted by Frankish

[879] Kedar, "The Outer Walls," pp. 174-75. This cemetery might correspond with the Frankish St Nicholas cemetery.
[880] For the defences along this section of wall, see Pringle, *Churches*, 4:11; Pringle, "Edward I," p. 53.
[881] Templar of Tyre, *Gestes des Chiprois* 491, ed. Minervini, p. 208, trans. Crawford, pp. 106-7; Marino Sanudo, *Liber secretorum* 3.12.21, ed. Bongars, p. 230, trans. Lock, p. 367; *Amadi*, ed. De Mas Latrie, p. 220.
[882] Templar of Tyre, *Gestes des Chiprois* 493, ed. Minervini, p. 212, trans. Crawford, p. 108; Marino Sanudo, *Liber secretorum* 3.12.21, ed. Bongars, pp. 230-31, trans. Lock, pp. 367-68; *Excidium Aconis* 2.3, ll. 148-56, ed. Huygens, pp. 68-69; Ibn Taghribirdi, trans. Gabrieli in *Arab Historians*, p. 347; D'Souza, "The Conquest of 'Akka," p. 243.

artillery in a failed last effort to keep it out of Muslim hands.[883] In an anecdote about his own involvement, Baybars al-Mansuri claims that a felt screen was used to approach the damaged section of wall, sufficient to absorb the shock of incoming artillery fire, evidently that of traction trebuchets, and resist arrows. This screen was then used to shelter those filling the fosse ahead of the frontal attack which would be focused here.[884]

Acre: projectiles on display (author)

The Muslims began an assault on all fronts at dawn on 18 May 1291. Preventing the Franks from concentrating their manpower, the breach in the outer wall was quickly stormed. As the attackers passed through the breach they spread out along the northern and eastern inner walls and, as panic set in and the first defenders began to flee towards the sea, the Muslim forces started to scale the inner walls. A door in the Accursed Tower was also forced, leading some of the Mamluks to the churchyard of St Romanus and the artillery that the Pisans had erected there.[885] While some paused to burn the heaviest engine, others continued south along the inner side of the east wall.[886]

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883 Templar of Tyre, *Gestes des Chiprois* 494, ed. Minervini, pp. 212-14, trans. Crawford, p. 109; Marino Sanudo, *Liber secretorum* 3.12.21, ed. Bongars, p. 231, trans. Lock, p. 368. See also *Excidium Aconis* 2.3, ll. 165-69, ed. Huygens, pp. 69.

884 Little, "The Fall of 'Akka," pp. 172-73.

885 For this structure and its location, see Pringle, *Churches*, no. 442, 4:158.

886 Templar of Tyre, *Gestes des Chiprois* 496-99, ed. Minervini, pp. 214-20, trans. Crawford, pp. 110-13; Marino Sanudo, *Liber secretorum* 3.12.21, ed. Bongars, p. 231, trans. Lock, p. 368; letter of John of Villiers to William of Villaret, in *Carticulaire général des Hospitaliers*, no. 4,157, 3:593; Ibn Taghribirdi, trans. Gabrieli in *Arab Historians*, p. 347; Abu'l-Fida', *al-Mukhtasar*, trans. Holt, p. 17; D'Souza, "The Conquest of 'Akka," p. 244. See also al-Maqrizi, *al-Suluk*, trans. Quatremère 2:125-26; *Excidium Aconis* 2.4-12, ll.

Acre: projectiles, Hospitaller complex (author)

As the city was steadily overwhelmed, the Templars' complex in the southwest corner of the city, partly secured by the sea, hosted the defenders' last stand, until it too was undermined about ten days later. When the last bastion fell, al-Ashraf ordered Frankish Acre demolished.[887]

Artillery does not reappear in the narrative once the Muslims broke into the city: none of the Mamluks' engines were apparently brought in to use against the Templar complex nor were any Frankish engines turned against them. It is unclear whether some of the Frankish engines were disassembled and distributed through Syria or if most were simply destroyed along with the rest of Acre.[888] So thorough was the destruction that the medieval walls have all but disappeared, leaving no indication of the power of the engines that played against them in 1291.

It is notable that mining was once more responsible for breaching Acre's defences. Although there are indications that artillery was developing into a breaching weapon, possibly used as such at Tripoli and Acre, it was never successfully employed in this capacity before the end of the Frankish period. Like the thin south wall at Montfort, the walls of the thirteenth-century tower that anchored the extreme north-west end of Montmusard's defences were only 1 m thick.[889] Thin walls like these check any drastic overestimations of the power of these engines, despite the large stones that have been discovered beyond the city's medieval walls since the seventeenth century, some more than 30 cm in diameter. Without any physical evidence of damage, as at Arsuf, or a discernible range, as at Montfort, there is little to conclusively suggest how far or

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180-742, ed. Huygens, pp. 70-93; Thadeus, *Ystoria* ll. 62-77, 709-24, ed. Huygens, pp. 101-2, 127; Ludolph of Suchem, *De itinere Terrae sanctae liber* 26, ed. Deycks, pp. 43-45, trans. Stewart, pp. 56-58.

[887] For later testimony of this destruction, see Ibn Battuta, *Tuhfat* 1.1, trans. Gibb, pp. 57-58.

[888] Templar of Tyre, *Gestes des Chiprois* 501, ed. Minervini, pp. 220-22, trans. Crawford, p. 114; *Amadi*, ed. De Mas Latrie, p. 222; Thadeus, *Ystoria* ll. 252-67, ed. Huygens, pp. 109-10; Ludolph of Suchem, *De itinere Terrae sanctae liber* 26, ed. Deycks, pp. 45-46, trans. Stewart, pp. 59-60; Ibn Taghribirdi, trans. Gabrieli in *Arab Historians*, pp. 348-49; Little, "The Fall of 'Akka," p. 176; D'Souza, "The Conquest of 'Akka," p. 246.

[889] Frankel, "The North-Western Corner," p. 256; Kedar, "The Outer Walls," pp. 60-61.

effectively such stones could have been thrown or how much the corresponding engines had grown since previous sieges.

'Ajlun: projectiles on display (author)

Fittingly, it is at this final siege that the largest projectiles have been found. Although a visit to the Hospitaller complex, where many of these stones are kept, can leave the impression that only such large projectiles were thrown, similar in scale to fourteenth-century stones stockpiled elsewhere by the Mamluks, their number should instead reflect the significant number of large engines that were present during the siege and their continued use for more than six weeks. There is every indication that smaller projectiles, both easier to find and throw, would have greatly outnumbered these; however, their less impressive size has allowed them to avoid the same degree of attention over the centuries. The diversity of engine-types found in the sources and the emphasis placed on the use of these smaller engines at various points, would seem to confirm this.

The Aftermath

As fell Acre, so fell the Latin presence in the Levant. Tyre, which had never fallen from Frankish hands since it was taken in 1124, was surrendered to the Mamluks by those who had not already fled.[890] The Templars considered defending Sidon but it too was abandoned, as was Beirut and eventually 'Atlit and Tortosa.[891] The Mamluks then slighted all of these coastal strongholds. The speed with which these defences were abandoned speaks to the real strength of the Mamluks: their comparative numbers. Although these stoutly fortified strongholds could probably have withstood the most formidable artillery

[890] Templar of Tyre, *Gestes des Chiprois* 504, ed. Minervini, p. 204, trans. Crawford, p. 504. Marino Sanudo, *Liber secretorum* 3.12.22, ed. Bongars, pp. 231-32, trans. Lock, p. 369; Abu'l-Fida', *al-Mukhtasar*, trans. Holt, p. 17; Ibn Taghribirdi, trans. Gabrieli in *Arab Historians*, p. 349-50.

[891] Templar of Tyre, *Gestes des Chiprois* 509-12, ed. Minervini, pp. 226-28, trans. Crawford, pp. 118-19; Marino Sanudo, *Liber secretorum* 3.12.22, ed. Bongars, p. 232, trans. Lock, p. 369; Abu'l-Fida', *al-Mukhtasar*, trans. Holt, p. 17. John Poloner was impressed by the ruined remains of Sidon's castles in the fifteenth century but Mandrell appears not to even have noticed the sea castle two hundred and fifty years later, John Poloner, *Descriptio Terrae Sanctae*, trans. Stewart, pp. 29-30, 32; Mandrell, *A Journey*, p. 60.

for weeks, if not months, al-Ashraf's reserves of manpower would have allowed him to sacrifice waves of men in frontal assaults or to impose blockades with the knowledge that they would face no field army to the rear. Although the Templars continued to hold the island of Ruad (Arwad) off the coat of Tortosa until 1302,[892] and calls for crusades were made into the fourteenth century, the period of Frankish lordship in the Levant effectively ended with the loss of Acre. With this, almost two hundred years of Frankish-Muslim cohabitation and side-by-side artillery development in the Near East also came to an end.

[892] Templar of Tyre, *Gestes des Chiprois* 615-23, 635-38, ed. Minervini, pp. 300-4, 308-10, trans. Crawford, pp. 155-58, 160-61; Abu'l-Fida', *al-Mukhtasar*, trans. Holt, p. 40.

PART THREE:

INFLUENCE AND INTERPRETATION

8. Offensive Artillery and Fortification Design

In the nineteenth century, the famed historian, architect and architectural restorer, Eugene Emanuel Viollet-le-Duc remarked, "We cannot doubt that the crusades, during which so many memorable sieges were effected, improved the means of attack, and that consequently important modifications were introduced into the defence of fortified places."[893] As the means of attack and defence advanced, it is widely contested to what degree siege engines were a driving, rather than reciprocally developing, element of this process. In Viollet-le-Duc's opinion, up to the thirteenth century fortifications remained essentially static bulks of masonry, defended by small garrisons. Without expressly stating why or examining the underlying causes, he concluded that it was a direct result of the crusades that this type of defence was no longer sufficient and more methodically built fortifications, with larger, more active, garrisons were built form the late twelfth century.

Opinions such as those expressed by Viollet-le-Duc, reflect noticeable changes in the style and scale of fortifications built in Latin Europe and the Near East at the end of the twelfth century and start of the thirteenth. Because the crusades were a natural point of exposure between Latin Christians and Turco-Arabic Muslims, they have been regarded at times as a semi-mystical source of cross-cultural technological sharing and development. The construction of some of the most impressive strongholds of this perceived transition phase in and around the Frankish East has contributed to this notion. These impressive castles and citadels, often of a larger scale with thicker walls and a more concentric plan than earlier examples, are frequently viewed as the result of some acute need to completely replace outdated twelfth-century fortification styles with stronger and

[893] Viollet-le-Duc, *Dictionnaire*, 1:341-42, trans. Macdermott, in *An Essay*, p. 31.

more 'scientific' designs. The introduction of heavy counterweight trebuchets is often regarded as the impetus behind this change.

Theories Regarding the Influence of Artillery

In the early twentieth century, Sydney Toy attributed the declining use of medieval rams to the superseding power of swing-beam artillery.[894] Taking matters much further, Paul Chevedden has emerged as the champion of those arguing that the power of artillery during the Early and High Middle Ages has been grossly underestimated. The breadth of his studies is commendable and the subsequent impact of his arguments on general interpretations of medieval artillery cannot be understated.

Chevedden claims that the counterweight trebuchet was nothing less than the Big Bertha of the pre-modern era, used to demolish fortifications with projectiles weighing hundreds of kilograms.[895] What began as a PhD thesis addressing al-'Adil's massive towers at Damascus, has developed into a broader theory explaining what he sees as a revolution in fortification, necessitated by a need to defend against powerful offensive artillery and to mount similar engines on top of towers.[896] In Chevedden's own words,

> The counterweight trebuchet was so far superior to any piece of artillery yet invented that its introduction brought about a revolution in siegecraft that rendered existing systems of defence obsolete. This gravity-powered siege-engine could discharge missiles of far greater weight than the traction or hybrid machines, and it could do so with remarkable accuracy. The machine was thus able to deliver devastating blows against the same spot of masonry time after time, and this made it potentially capable of demolishing the strongest fortified enclosures. The introduction of the counterweight trebuchet led to an increase in the scale of warfare and produced revolutionary changes in military architecture in order to counter the greater destructive power of this new artillery.[897]

This theory was embraced by Hugh Kennedy and widely circulated in his notable work on crusader castles:

[894] Toy, *Castles*, p. 142.
[895] Chevedden, "King James I," p. 313.
[896] See Chevedden, *The Citadel of Damascus*, pp. 283-84; Chevedden, "Fortifications," p. 36; Chevedden, "Invention," p. 71.
[897] Chevedden, "Invention," p. 76.

> The development of this new and improved artillery fundamentally changed the balance between attack and defence. The engines became so effective that, given uninterrupted firing time, they would reduce any fortress to rubble. It was no use sitting behind castle walls and trusting in their strength: unless the defenders took active measures to neutralise the artillery, the fortress they had built would be destroyed as surely as the incoming tide washes away the children's sandcastle.[898]

It is perhaps revealing that Chevedden's earliest and most poignant arguments focus on defensive artillery: the power of offensive artillery is emphasised in order to support a theory that defenders would have wanted to employ the same engines in defence. Accordingly, he suggests that the large mural towers built by al-'Adil were platforms for the heaviest contemporary counterweight trebuchets.[899]

Throughout his work, Chevedden attempts to place the invention of the counterweight trebuchet as early as possible. But by doing this, he is forced to suggest that the century between the invention of this type of engine, supposedly by Alexius Comnenus, and al-'Adil's construction campaign was one of development and experimentation.[900] In the absence of evidence, he has relied upon a selection of isolated examples, pooled from Iberia to Anatolia, to support the notion that counterweight trebuchets were employed at this time. However, the ease with which knowledge of a small counterweight trebuchet allows for the construction of a much larger engine, and the futility of employing small counterweight trebuchets, render such a long period of development unlikely. Furthermore, there is very little evidence to indicate that breaching artillery was employed by the time of al-'Adil's death, suggesting that the design of his towers was influenced by other factors.

Looking at Frankish fortifications in the kingdom of Jerusalem, Ronnie Ellenblum has suggested that the construction of larger more sophisticated Frankish castles and the development of concentric defences in the last third of the twelfth century was a response

[898] Kennedy, *Crusader Castles*, p. 108.

[899] See also Kennedy, *Crusader Castles*, p. 182; Nicolle, *Crusader Castles*, p. 44. Such arguments will be dealt with in Chapter 9.

[900] See Chevedden, "Invention," p. 73. Chevedden inappropriately cites a supposed delay between the introduction of effective siege guns and the inception of the bastion system of defence as a comparison. In reality, there was hardly a delay: the earliest polygonal bastions actually predate the effective use of light and mobile siege guns by the French during the Italian Wars from 1494. By the 1530s, polygonal fortifications had been built throughout the Italian peninsula, from the small forts of Nettuno and Barletta to elaborate urban defences of Ferrera, Lucca, Verona and Florence. See Mallett, "The Transformation of War, 1494-1530," pp. 3-21; Pepper, "The Face of the Siege," pp. 33-56; Black, *European Warfare, 1494-1660*; Parker, "The 'Military Revolution'," pp. 196-214.

to the Muslims' use of heavy artillery.[901] Concentricity, according to Ellenblum, was the only defence against this shift to heavy siege equipment.[902] However, evidence to support this theory is less forthcoming than he would make it out to be. The castle at Jacob's Ford, which was captured without the aid of artillery in 1179, was one of only a few castles to be taken between 1160 and 1186. The walls of this stronghold appear to have been incomplete when it was attacked, in some areas only slightly higher than the earth piled up against them, probably serving as scaffolding,[903] and there is no firm evidence to confirm that the stronghold was ever intended to have an outer wall, one was certainly not present in 1179. While no artillery appears to have been used at Jacob's Ford, Ellenblum claims that the two engines that were used against Kerak in 1170 were counterweight trebuchets.[904] How he arrived at this conclusion is unclear, as is why he fails to address the subsequent sieges of 1183 and 1184, where many more stone-throwers were employed with greater effect. Critically, at none of these sieges is there any suggestion that artillery threatened the integrity of the castle's defences.[905]

When examining the more general shift in the balance of power during the twelfth century, Ellenblum notes that Muslim sieges began to last longer as a result of the growing resources of Nur al-Din and Saladin. In an effort to juxtapose this with the supposedly drastically increased power of artillery, he suggests that the Franks took pre-emptive efforts to strengthen their fortifications.[906] Although he discusses certain strongholds, he neglects any examination of the machines that he judges to be responsible for this supposedly drastic shift in fortification design.

Similarly, David Nicolle has emphasised the similarities between late Roman walls and those constructed by the Franks in the twelfth century. Highlighting tower spacing and projection as well as wall thickness, he implicitly ties these similarities to the

[901] Ellenblum, *Crusader Castles*, p. 237, cf. pp. 177-81. Ellenblum's presumption that many Frankish castles were dramatically developed during this period is largely pinned on a single passage in James of Vitry's history. Writing in the early thirteenth century, James of Vitry places the construction of Montreal, Kerak, Safed and Belvoir with the events of 1168, following Amalric's failed campaign in Egypt. Ellenblum suggests James of Vitry's remarks indicate that these castles were significantly developed around this time, acknowledging that earlier contemporary accounts confirm that most of these castles were built decades earlier, Ellenblum, *Crusader Castles*, pp. 177-81. Cf. James of Vitry, *Historia orientalis* 49, ed. and trans. Donnadieu, pp. 216-17.
[902] Ellenblum, *Crusader Castles*, p. 284.
[903] Cf. Ellenblum, *Crusader Castles*, p. 269-70.
[904] Ellenblum, *Crusader Castles*, p. 258.
[905] For discussions of the various sieges of Kerak, see Chapter 4.
[906] Ellenblum, *Crusader Castles*, p. 237.

comparable power of Roman and early-twelfth-century artillery.[907] Nicolle, following Ellenblum, interprets the Frankish fortification efforts of the 1160s and 1170s as a response to the effective employment of counterweight trebuchets, decades before al-'Adil's building efforts.[908] Nicolle risks contradicting this, however, when suggesting that this was also a period of continuity in siege warfare, as expressed by France and Marshall, ultimately conceding that the capabilities of counterweight trebuchets may often be significantly overstated.[909]

The issue with each of these theories is that they interpret the power of artillery purely through the hypothesis that it alone was responsible for the discernible shifts that may be seen in the design of fortifications in the late twelfth century. However, a number of other factors contributed to the construction of larger and more sophisticated castles around this time. Not least among these are the greater financial resources of their commissioners, the natural development/enlargement of existing structures and the opportunities for rebuilding in the latest style provided by the destruction wrought by earthquakes.

On the other side of this debate, Christopher Marshall has argued that the methods of attack and defence remained largely the same through the thirteenth century as they had been during the twelfth, suggesting that there was little technological change.[910] This echoes sentiments expressed by Viollet-le-Duc, who asserted that even counterweight-powered artillery could do little more than destroy crenellations, clear defenders from parapets and target the machines of the besieged, a view shared by Oman.[911] John France has also supported this notion of continuity and a more obvious balance between attack and defence.

Without having studied artillery in depth, France appears to appreciate the limitations of this period's artillery, whether traction- or counterweight-powered, better than most.[912] Placing these engines in a more appropriate tactical context, his conclusions

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907 Nicolle, *Crusader Castles*, p. 57. Chevedden also alludes to these similarities, Chevedden, *The Citadel of Damascus*, pp. 7-8.

908 Nicolle, *Crusader Castles*, p. 31. Michaudel has also accepted the influence of the counterweight trebuchet in driving the development of fortifications, through in a much broader and more subdued Ayyubid-Mamluk context, Michaudel, "Development of Islamic Military Architecture," p. 106.

909 Nicolle, *Crusader Castles*, pp. 139, 142.

910 Marshall, *Warfare in the Latin East*, p. 212.

911 Viollet-le-Duc, *Dictionnaire*, 1:344, trans. Macdermott, in *An Essay*, p. 36; Oman, *The Art of War in the Middle Ages*, pp. 57-61; Oman, *A History of the Art of War*, p. 131.

912 His acceptance that al-Zahir Ghazi's artillery breached the western bailey at Saone in 1188 is uncharacteristic of his otherwise critical treatment of artillery.

echo those expressed by Viollet-le-Duc.[913] In the vast majority of instances where artillery is mentioned by the sources, it is not depicted as a kind of super-weapon but merely one of many familiar tools that could be used during a siege.

Siege Length

Perceived trends towards both longer and shorter sieges have been used to argue the increased use of heavy artillery. While Ellenblum has argued the former in the context of Saladin's sieges of the late twelfth century,[914] the latter is often suggested in the context of the Mamluk period. Hugh Kennedy and Carole Hillenbrand have both viewed the brevity of certain Mamluk sieges as evidence of their more efficient use of artillery.[915] But such arguments rely heavily on circumstantial evidence, as neither approach takes into account the changing political climate and discrepancy between the resources of the various parties. While no Mamluk siege of a Frankish castle lasted more than six weeks, at no point did Saladin ever besiege a Frankish stronghold, in person, for a period of time any longer.[916]

Arguments focusing on the relative brevity of Mamluk sieges stem largely from a theory proposed by Christopher Marshall, which asserts that Muslim sieges of Latin strongholds in the thirteenth century lasted no more than a few weeks, while Frankish forces were content to besiege an objective for months.[917] What is not emphasised is that all of these protracted Frankish sieges, save that of Damietta in 1218-19, were directed against the strongholds of fellow Franks.[918] Although his data is somewhat skewed, Marshall sensibly acknowledges that the most important factor contributing to the brevity of most Muslim sieges of Frankish strongholds was the overwhelming manpower that the Muslims were able to bring against them.[919] Rather than a tactical preference, the Muslims' more aggressive approach was a by-product of their ability to commit

[913] France, *Western Warfare*, pp. 119-26.
[914] Ellenblum, *Crusader Castles*, p. 284.
[915] Kennedy, *Crusader Castles*, p. 101; Hillenbrand, *the Crusades*, p. 531.
[916] The intermittent sieges of Belvoir (1187-89) and Beaufort (1189-90) are the closest to an exception.
[917] Marshall, *Warfare in the Latin East*, pp. 241-46.
[918] When considering those between Christian powers, both the ongoing Ibelin-Imperialist and Genoese-Venetian conflicts were tied to affairs in Europe.
[919] Marshall, *Warfare in the Latin East*, pp. 247-48.

significant numbers to frontal assaults and incur high numerical losses. The cost of maintaining large armies in the field also contributed to some of the more aggressive siege strategies demonstrated by Zanki, Saladin and Baybars. The prospect of becoming bogged down in a lengthy siege, yielding few profits and often far from home, would also have encouraged opposition from the various contingents within the army.

When considering Frankish sieges of the twelfth century, most of the longest involved large contingents of crusaders, such as those of Antioch (1097-98) and Acre (1189-91), similar to the later siege of Damietta, while many of the prolonged sieges of coastal strongholds, such as Tyre (1124), involved considerable Italian naval support. The few that remain, such as the lengthy siege of Ascalon (1153), can be contrasted with the majority of Frankish sieges, which, like that of Banyas (1140), were concluded in a matter of weeks.

Artillery had little effect on the length of most sieges. It remained a supporting weapon through the twelfth century and most of the thirteenth. Furthermore, neither the Franks nor the Muslims appear to have employed significantly stronger engines or built considerably stouter fortifications than the other.

Development, Power and Resources

The earthquakes of 1157, 1170 and 1202 necessitated the rebuilding of many Frankish and Muslim fortifications throughout greater Syria.[920] While Nur al-Din's rebuilding efforts might be seen as stylistically 'traditional', a number of Frankish castles rebuilt at the same time are often viewed as radically innovative. Belvoir, built by the Hospitallers from around 1168 in two concentric squares, is the most exceptional. Crac des Chevaliers was also rebuilt by the Hospitallers from around 1170, but it was far from the mighty thirteenth-century castle that it would become. At the end of the twelfth century, Crac may have had a plan very similar to that of the contemporary Templar castle at Jacob's

[920] For these tremors, see Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 326, 328-30, 338-40; Matthew of Edessa, *Patmowt'iwn*, trans. Dostourian, p. 267; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:87, 89, 185-86; *Anonymous Syriac Chronicle*, trans. Tritton, pp. 302-3; William of Tyre, *Chronicon* 20.18, ed. Huygens, pp. 934-36, trans. Babcock and Krey, 2:370-71; letter from Geoffrey of Donjon, master of the Hospitallers, to Sancho VII of Navarra, and letter from Philip of Plessis, master of the Templars, to the abbot of Cîteaux, ed. Meyer in "Two Unpublished Letters on the Syrian Earthquake of 1202," pp. 306-10.

Ford.[921] In Transjordan, Montreal and Kerak were spared the effects of these earthquakes: their impressive Frankish defences are the product of continuous development by their wealthy lords, while both were developed further by the Mamluks in the thirteenth century.[922] As Belvoir would appear to be the only drastically different or considerably stronger Frankish castle built in a single phase in the late twelfth century, there is minimal evidence of a drastic architectural shift before the crisis of 1187. Most castles, like those elsewhere in the Near East and Europe, were the result of multiple phases of improvement and continual rather than one-time investment.

The fortifications constructed in the last third of the twelfth century would have been designed with contemporary artillery in mind. Likewise, those that were not developed by proprietors who had the means to do so were probably judged to be sufficiently strong. Critically, both Frankish and Muslim defences dating to this period display towers of a similar scale to those built much earlier in the twelfth century and walls of a thickness similar to preceding fortification traditions. The architecture, therefore, appears to support the textual evidence: artillery, even if counterweight-powered, was not a significant threat to fortified masonry in the 1170s, nor in the 1180s if Saladin's defences at Cairo are considered. Not until the early thirteenth century is there a notable shift.

The military orders were responsible for an increasing proportion of the Franks' rural castles from the late twelfth century. Their enlargement of certain strongholds in the early thirteenth century must be seen in the context of their greater wealth and the drastically different balance of political power after the events of 1187. When assessing the development of any stronghold, it is necessary to analyse both the socio-political situation and financial resources of the commissioner as well as the potential threats to the stronghold's security.

Fortifications ultimately reflect the wealth of those who built them and the resources that they were prepared to invest. The greatest castles built by the baronage during the twelfth century were constructed by the realm's wealthiest nobles; however,

[921] For a study of Crac as it may have stood at the end of the twelfth century, see Biller, "Die erste Burg der Johanniter (nach 1170)," pp. 47-77.

[922] For the foundation and development of Montreal, see Fulcher of Chartres, *Historia Hierosolymitana* 2.55, ed. Hagenmeyer, pp. 592-93, trans. Ryan p. 215; Albert of Aachen, *Historia Ierosolimitana* 12.21, ed. and trans. Edgington, pp. 856-57; Faucherre, et al., "La forteresse de Shawbak," pp. 50-64; Pringle, *Churches*, 2:304-14. For the foundation and development of Kerak, see William of Tyre, *Chronicon* 15.21, 22.28, ed. Huygens, 2:692-93, 1,055-56, trans. Babcock and Krey 2:127, 499. See also Deschamps, *Les Châteaux*, 2:35-98.

most of the kingdom's larger castles dating to the first half of the twelfth century were founded and financed by the monarchy.[923] Of these, most were bestowed upon the secular baronage and the military orders, a practice which continued up to the construction of Jacob's Ford. By the reign of Amalric, the nobility was increasingly reorienting its focus from the countryside to the coastal towns, taking advantage of both the prosperity and security of these regions. The wealth of the military orders permitted them to acquire a number of former baronial castles, which they could afford to defend and even develop sometimes. Most of the strongholds that Saladin failed to take or bypassed in 1187-88, including Chastel Blanc, Tortosa, Crac des Chevaliers and Margat, belonged to the military orders. The extended resistance of Templar Safed and Hospitaller Belvoir can also be cited. However, some castles, such as Beaufort, Saone and Kerak, remained under secular nobles, who could afford their upkeep, until they were lost in the aftermath of Hattin.

The loss of Frankish lands in the 1180s further encouraged the baronage to sell their inland properties to the military orders. The impoverished monarchy, and efforts of visiting crusaders, such as Richard I of England, Frederic II of Germany, Richard of Cornwall and Louis IX of France, focused on developing the coastal fortifications responsible for defending the largest Frankish populations, commerce and links with Europe. The Templars developed coastal 'Atlit and Tortosa for similar reasons.

Further inland, most territories that were reacquired during the Third Crusade or afterwards, were far more exposed than they had been during most of the twelfth century. The military orders recognised that any besieging force that invested one of their inland castles would almost certainly be larger than most of those encountered during the twelfth century while any friendly relieving force would be comparatively smaller and slower to muster. This meant that these strongholds might even need to hold out longer than the enemy could afford to besiege them. It was these factors that led to the construction/development of such strong Frankish castles as 'Atlit and Crac des Chevaliers in the early thirteenth century, not the appearance of some new or drastically more powerful type of artillery.

[923] The vast majority of fortified structures built by the Franks during the twelfth century were small towers. Constructed by various landholders, these were centres of administration and even residences as much as defensible strongpoints. In this way, they bear certain similarities to the seventh- through eight-century system of land control established by the Islamic lords of the Near East, see Carver, "Transition to Islam," pp. 192-93. For the Frankish structures see Pringle, *The Red Tower*.

Concentricity

Although there was continuity in the principles and methods of attack and defence from 1097 to 1291, this was not a period without advance in the methods and technology of both defence and attack. While artillery may have improved more than any other kind of offensive weaponry, mining remained the most effective technique for breaching walls. It was mining, coupled with the numerical strength of thirteenth-century Muslim armies that most likely encouraged the Franks to build their defences with increasing depth. Utilising multiple lines of defence placed as many obstacles as possible between any hostile adversary and a final point of defence, from which a last stand could be made or terms of surrender could be negotiated. In most instances, concentricity was the product of progressive development rather than a single construction phase: a tendency to add further lines of defences around pre-existing ones.[924]

When encountering any stronghold, a besieger had to calculate the strength of the obstacles that it presented and the expense in specie and manpower that it would take to overcome them. Furthermore, factors of morale had to be considered and the costs of assaults and blockades of varying degrees of aggression had to be weighed against the likelihood that the garrison would be relieved before success was achieved. Saladin's avoidance of certain castles in 1188, such as Crac and Margat, reflects this, as do the relatively passive blockades of Kerak and Montreal.

Any stronghold could be taken provided the besieger had an endless supply of assault troops; however, mining was the most efficient means of breaching a defensive trace in the twelfth and thirteenth centuries. In addition to multiple lines of fortifications, through-columns, ditches and taluses were employed to discourage or frustrate sappers.[925] Testament to the effectiveness of this approach, the latest defences built at Acre appear to have been those that were undermined in 1291. Mining and frontal attacks, rather than artillery, were the most significant threats that encouraged the construction of these added lines of defence.

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[924] The addition of surrounding walls to early twelfth-century towers were some of the earliest examples of this. For numerous examples, see Pringle, *Secular Buildings*; Pringle, *The Red Tower*.

[925] The former is explained by Ibn 'Abd al-Zahir and Ibn al-Furat in the context of Caesarea, Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:555-56; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:70. See also Vitruvius, *De architectura* 2.8.7, ed. Krohn, p. 43, trans. Morgan, pp. 52-53. For a brief introduction to their use in the Levant during the twelfth and thirteenth centuries, see Yovitchitch, *Forteresses*, pp. 84-88.

Wall Thickness

Perhaps the most definitive evidence of the limited power of this period's artillery is the relative continuity of wall thicknesses. Ellenblum and Raphael have argued the opposite, suggesting that the average thickness of fortified walls in the kingdom of Jerusalem increased from about 2-2.5 m in the early and mid-twelfth century to 4-5 m in the 1160s. Having based their conclusions on only six examples (Bethgibelin, Kerak, Belvoir, Jacob's Ford, 'Atlit and Caesarea), using a single measurement from each to characterise the strength of the entire stronghold, the fallibility of their conclusions is readily apparent.[926]

'Atlit:

When wall thickness is discussed, the 5 m thick walls of 'Atlit's two inner towers are frequently referenced; however, the castle's 200 m long outer wall is even thicker.[927] This wall is 6.5 m thick and solid at the first level. A mural gallery halves the thickness of the wall at the second level, providing access to casemates and creating an additional fighting level below the parapet.[928] The walls of the three mural towers mimic this: they are close to 6 m thick at the first level but the outward face of the second level is only 1 m thick, allowing for six embrasures in this wall of the southern and middle towers and four in that of the northern tower. The thickness of the curtain wall is also compromised at the second level in order to provide embrasures, each accessed via a casemate wide enough to accommodate two archers that extends more than 1 m into the thickness of the wall. Collectively, as many as seventy archers could have fired simultaneously from this level of the outer defences alone.[929]

The designers of this line obviously felt it necessary for the walls to be extremely thick at their base, but were quite willing to sacrifice this at the second level in order to

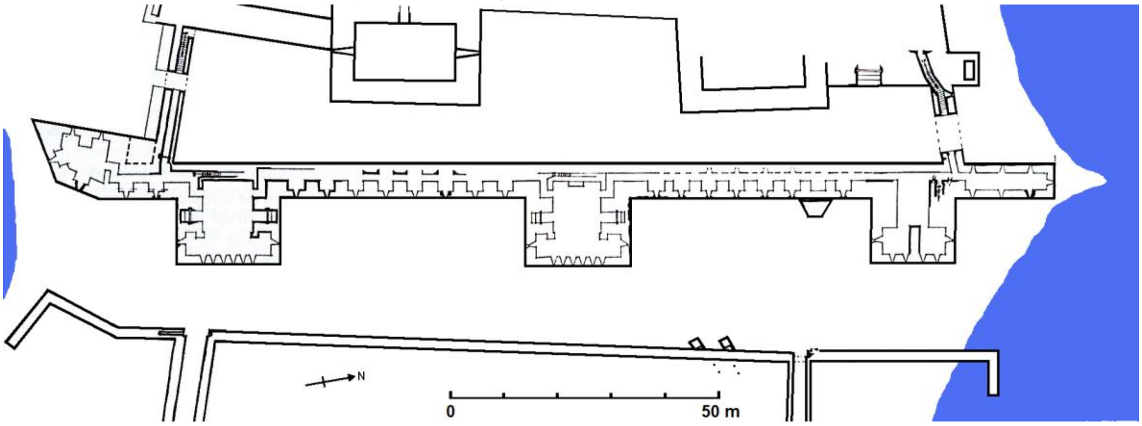
[926] Ellenblum, *Crusader Castles*, pp. 239-40; Raphael, *Muslim Fortresses*, pp. 42-43. There would appear to be little evidence to suggest that the thickest section of Kerak's Frankish defences, the northern wall, which is used to 'typify' the castle's defences, dates later than the 1140s.

[927] For excavations and observations at 'Atlit, see Johns *Guide to 'Atlit*; Rey, *Étude sur les monuments*, pp. 97-99; Conder and Kitchener, *Survey of Western Palestine*, 1:293-96.

[928] Boas, *Crusader Archaeology*, pp. 111-12.

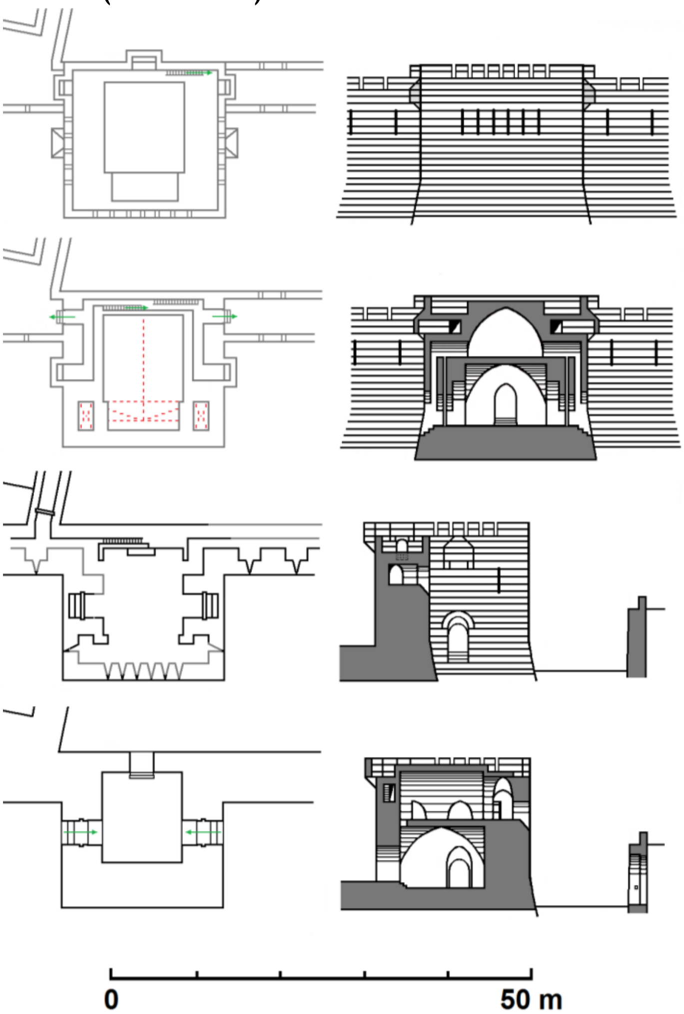
[929] Johns, *Guide to 'Atlit*, pp. 38-39; Johns, "Excavations at Pilgrims' Castle, (1932)," p. 153. This is based on the presumption that the spacing of the surviving casemates was continued along the ruined sections of the mural gallery and that the casemates, 3 m wide, were designed to incorporate two archers.

'Atlit: outer defences, plan (after Johns)



maximise the number of archers that could fire from within the wall, as well as on top of it. This suggests that mining and frontal assaults were feared most. The thin outer wall of the upper level of each tower would have been the most exposed to artillery fire, indicating that artillery was considered no more of a breaching weapon at this point than it had been earlier. The designers appear to have been vindicated shortly afterwards when, following an initial attack while the castle was still under construction, the fortress resisted Mu'azzam 'Isa's artillery in the autumn of 1220.[930] If these towers postdate the siege of 1220, there can be little doubt that the designers believed these tower walls to be strong enough to resist just such engines.

'Atlit: southern outer tower, plan, elevation and section (after Johns)



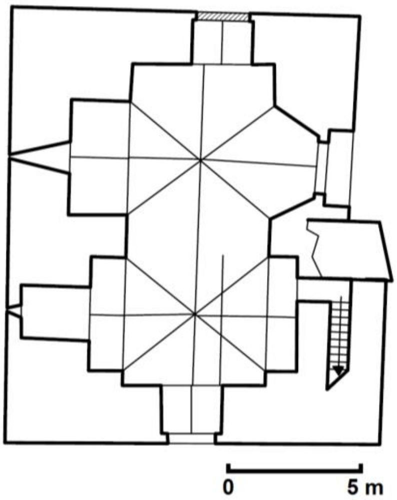
[930] For the sieges of 1218/19 and 1220, see Chapter 6.

Purpose and Inconsistency:

Whereas Ellenblum and Raphael characterise the walls of 'Atlit as 5 m thick, they portray those of Kerak as 2.5 m thick. This is thicker than some of the castle's eastern and western walls but thinner than the important north wall. At Montfort, which they inexplicably do not include, certain external walls are only about 1 m thick while those of the keep are up to 7 m thick. Although extremely thick walls were built in certain parts of some castles in the early thirteenth century, this was not done consistently along all exposed fronts.

As at 'Atlit, many of the thickest walls appear to have been built to accommodate defenders within or on top of them. At Subayba, the Ayyubid wall extending north from tower 9, originally 1.4 m thick, was thickened considerably in 1240. This seems to have been done to create a broad fighting platform above, as casemates about 4 m wide were inserted into the bulk of the wall below. To the east of tower 9, a similar platform was created by adding a 0.5 m backing to the wall, allowing for the construction of a barrel vault between the curtain and the nearby reservoir.[931] The thickening of Saone's outer eastern wall after 1188 may have been done with similar objectives.[932] At Bourzey, the Ayyubid curtain and tower walls are at least as thick as the previous Byzantine and Frankish walls, but their casemates extend much farther into the masonry than earlier ones. Other castles, such as Crac des Chevaliers and Tortosa weakened otherwise much thicker walls by creating mural galleries to accommodate small arms fire, as was done at 'Atlit.

Bourzey: tower 3, plan (after Mesqui)



Walls dating to the thirteenth century are not always thicker than those built earlier. The thickest Ayyubid walls at Subayba are comparable to the 2.4 m thick walls excavated around the northwest tower at Banyas,[933] while what appears to be the northern wall of the Frankish citadel of Tiberias is 3.4 m thick.[934] Likewise, sections of twelfth-

[931] Hartal, *al-Subayba*, pp. 94-99, 103.
[932] Michaudel, "Le château de Saône," p. 3. See also Michaudel, "Development of Islamic Military Architecture," pp. 113-16.
[933] This 10.6 m by 15.7 m tower was subsequently enclosed in a larger 18.8 m by 26.0 m tower, Hartal, "Banyas."
[934] Stepansky, "Tiberias, the Courtyard of the Jews"; Stepansky, "The Crusader Castle of Tiberias," p. 179. See also Pringle, *Churches*, 2:352-53 and fig. 99.

century Frankish masonry may be the thickest medieval walls at Beaufort, despite significant remodelling by both the Ayyubids and Mamluks.[935] The tenth-century tower that anchored the northern defences of the citadel of Shayzar are just as thick as those of the bridge tower constructed ahead of it by the Mamluks, while the Zankid curtain running in between is significantly thinner than both.[936]

At smaller sites, the subsequent outer walls built around Bethgibelin, Belmont, Latrun and St Elias (at-Taiyiba) appear to be thinner than the walls of their earlier keeps.[937] The same is true of the outer walls of Jubayl (Byblos) and Chastel Rouge (Qal'at Yahmur), although these castles might have been constructed in a single phase.[938] Similar trends can also be seen in Europe, as at Conisbrough where the keep, built around 1170, has walls 4.5 m thick but the later bailey walls are significantly thinner.[939]

The walls of towers built in the kingdom of Jerusalem during the early twelfth century average about 2.5 m thick.[940] Most fortified walls built by the Ayyubids during the thirteenth century are 2-3.5 m thick, similar to those built by the Franks. Although walls much thicker than this were built at certain sites, such exceptions are not unique to this period. Most classical walls were no more than about 2 m thick; however, the third-century Roman walls of Nicaea are twice as thick as the 1.6-2 m thick forewall built around them by the Lascarids in the thirteenth century.[941] The celebrated walls built by Theodosius II around Constantinople in the fifth-century are 5 m thick,[942] while Anna Comnena claims that the walls of Durazzo were so thick that four men could ride abreast along them.[943] The mud-brick main curtain of Raqqa, founded in the eighth century by

[935] This is accurate so long as Corvisier's judgement that the southwest circular bastion was built by the Ottomans, Corvisier, "Les campagnes de construction," pp. 243-66.
[936] Tonghini and Montevecchi, "The Fortification of the Access System," pp. 219-20.
[937] For Bethgibelin, see Cohen, "The Fortification of the Fortress of Gybelin," pp. 67-75. For Belmont, see Harper and Pringle, *Belmont Castle*. For Latrun, see Pringle, *Secular Buildings*, no. 136, pp. 64-65; Boas, *Archaeology of the Military Orders*, p. 111. For St Elias, see Pringle, *Secular Buildings*, no. 215, pp. 98-99.
[938] For Jubayl, see Deschamps, *Les Châteaux*, 3:203-15; Rey, *Étude sur les monuments*, pp. 217-19. For Chastel Rouge, see Mesqui, "Qal'at Yahmur"; Kennedy, *Crusader Castles*, pp. 73-75; Deschamps, *Les Châteaux*, 3:317-19.
[939] This castle was built by Hamelin of Warenne, grandson of Fulk of Jerusalem and uncle of Richard I of England. For the castle, see Brindle, "The Keep at Conisbrough Castle," pp. 61-65.
[940] Pringle, "Towers in Crusader Palestine," pp. 343-46.
[941] A. W. Lawrence, "A Skeletal History," pp. 172-73. The discrepancy here is likely attributable to the height of each wall, the inner wall being twice that of the thinner thirteenth-century outer wall.
[942] A. W. Lawrence, "A Skeletal History," p. 180.
[943] Anna Comnena, *Alexiad* 13.3, trans. Sewter, p. 403.

al-Mansur, is almost 6 m thick and enclosed by an outer wall 4.5 m thick.[944] These are all dwarfed by the 6.4-7.2 m thick Iron Age walls of Jerusalem.[945]

Although there is a slight rise in the average thickness of fortified walls between the twelfth century and the thirteenth, this appears to have had little to do with artillery. In some instances thick walls were built to provide a broad fighting platform while in others they were structurally necessary to build towers with more impressive vaulting or higher walls. It is closer to the end of the thirteenth century when tower walls, built by the Mamluks, become consistently thicker. But even as this took place, the thickness of curtain walls remained largely the same.

Mamluk Towers:

There are discernible trends towards the construction of stronger towers around the start of the Mamluk period. At Bosra, two of the earliest Ayyubid towers, 6 and 8, were encased by al-Salih Ayyub in 1249 and Nasir Yusuf in 1251 respectively. Al-Salih Isma'il had already wrapped al-'Adil's northwest corner tower with a talus in 1240-41 and about a decade later this was extended around many eastern sections of the citadel. While the talus was almost certainly used as a defence against mining, the motives for encasing towers 6 and 8 are less clear.[946]

At Subayba, towers 9 and 11, located at the west end of the castle, were significantly enlarged when they were encased after 1260. Rather than to protect these towers from mining or artillery, the expansion of tower 11 seems to have been done to construct an opulent upper level, while the bristling defences given to tower 9 may have been intended to shield the gateway at the base of tower 11. At Kerak, the original Frankish defences at the south end of the castle have been obscured by the present Mamluk tower. Whatever the form of the structure that once stood here, it was replaced by a tower with an exterior southern wall 6.5 m thick.[947] While the scale of this four-levelled tower indicates that it was built to inspire awe, the thickness of the outer wall and dedicating inscription appear to defy any attempt to erect artillery on the ridge to the south, from which the castle would have been in range by the end of the thirteenth century.

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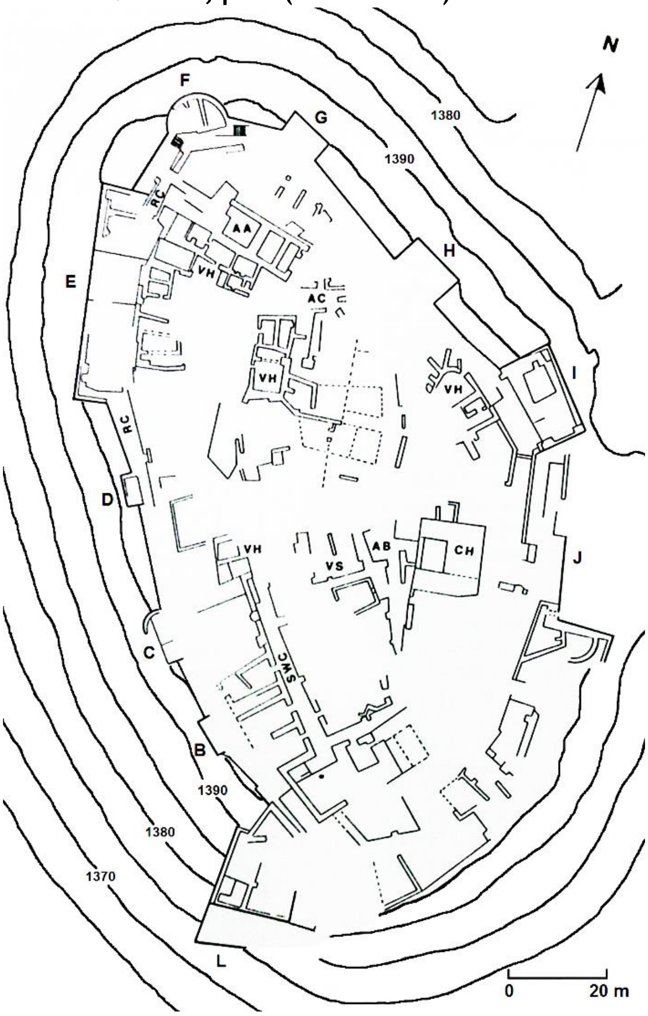
944 Creswell, "Fortification in Islam," p. 108.
945 Avigad, "Excavations in the Jewish Quarter," pp. 130-34.
946 The smaller towers may have been enlarged to giving the citadel a more uniform appearance from without.
947 Deschamps, *Les Châteaux*, 2:88-89.

Montreal: castle, plan (after Brown)

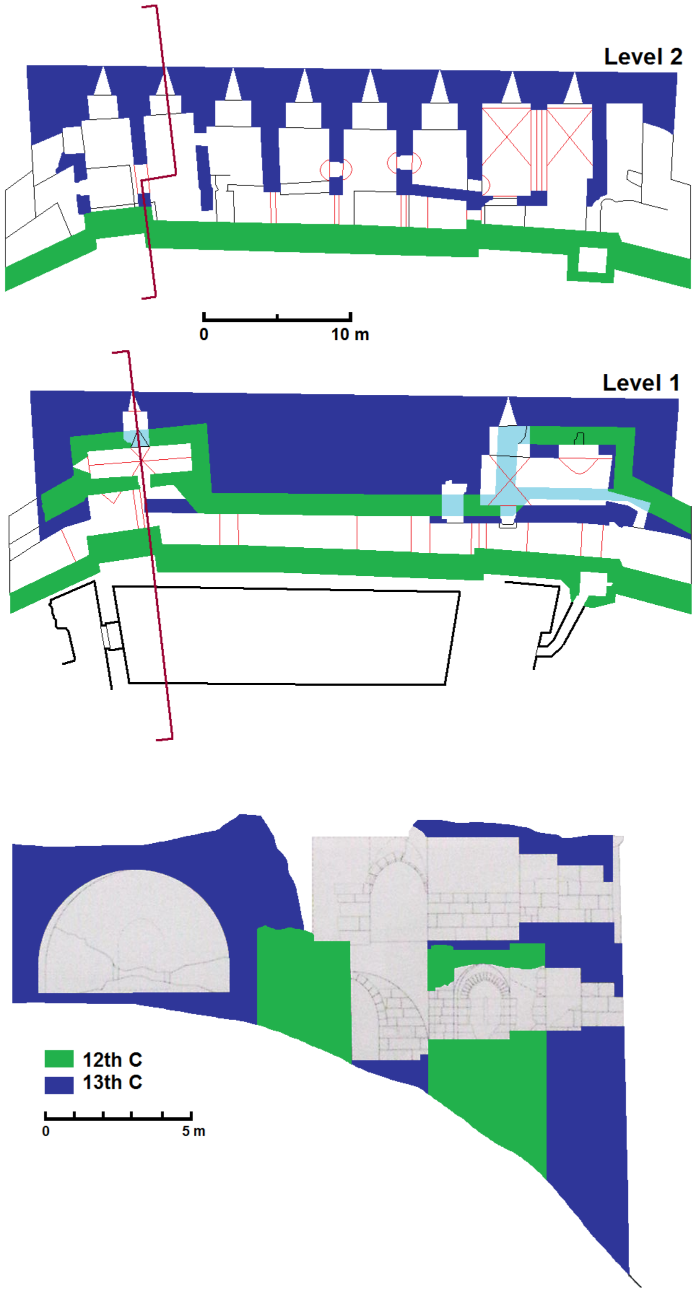


At Montreal, Mamluk towers E, F, I and L, as well as the less impressive G and H, appear to have been constructed around pre-existing Frankish towers.[948] While most of the earlier Frankish embrasures were enlarged into casemates, the lower levels of towers F and L, and possibly also G and H, were completely enclosed and some of tower E's Frankish embrasures were not carried forward. This initial loss of firepower at the lowest level was more than compensated for above. As at Subayba, the reason for expanding these towers appears to have been to allow more archers to fire outwards from a level below the battlements, the thickening of the walls being a byproduct. Tower E, as the most exposed, deserves closer examination: if Montfort was within range of heavy artillery in 1271, it stands to reason that tower E could have been assailed from the plateau to the northwest of the castle by this period.

Montreal's tower E displays an inscription to Husam al-Din Lajin, so would appear to postdate the program of destruction carried out by al-Ashraf Khalil in the early 1290s. Similar inscriptions on towers F and I indicate that these were part of a broader refortification effort that took place at a time when the effects of heavy counterweight artillery were known. Accordingly, it seems only reasonable to assume that the designers of tower E, the only one that could be practically bombarded by artillery, took such engines into consideration.

[948] For a recent study of the castle, see Faucherre, et al., "La forteresse de Shawbak," pp. 43-66.

Montreal: tower E, plan and section (after Faucherre



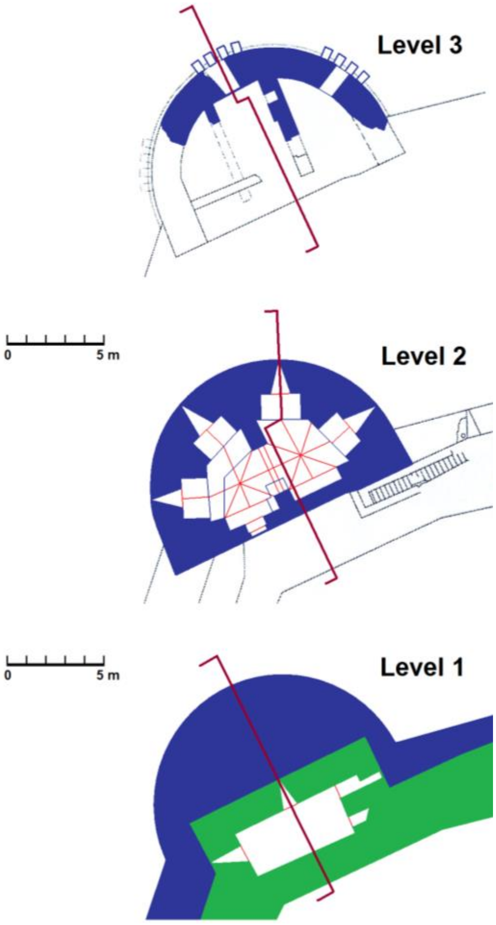
Tower E encases two earlier towers, stretching almost 40 m wide but projecting less than 10 m. Its base is solid, built down the slope in advance of the earlier fortifications in order to compensate for the gradient. At the first level, two casemates are accessible from the earlier Frankish towers. Between the two earlier towers is a solid mass of masonry, about 8 m thick, which supports a line of eight, or possibly nine, casemates at the second level. The third level was presumably an open fighting platform. The tower appears to have been expanded in order to allow more archers to fire at the plateau to the northeast of the castle. The solid base and stout lower level would have been resistant to the effects of both mining and artillery. At the second level, the sides of the roughly 3.5 m wide casemates extend back the entire width of the solid wall below. This compartmentalisation would have restricted the spread of damage if a breach were opened at the end of one of the casemates, while the breach itself would be quite high and hard for an assailant to access.

Unlike contemporary towers L and I, tower E was not provided with a glacis, nor were embrasures created in its flanks.[949] Focused solely on the northwestern plateau, and with no apparent means of defending the base of the tower, the tower's designers feared

[949] The length of these two glacises, extending longer at their northern ends, possibly indicate that they were partly intended to obstruct passage around the base of the castle. For these defences see Faucherre, et al., "La forteresse de Shawbak," pp. 43-66.

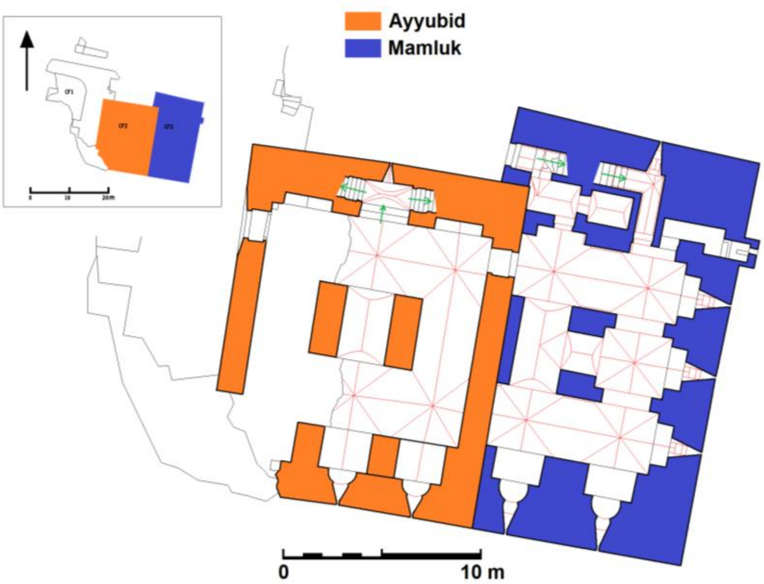
neither a massed assault nor mining here. Tower F would appear to have been expanded for similar reasons: the shallow Frankish tower was replaced by a rounded one, providing its four embrasures with a better field of fire. The expansion of tower L also provided more embrasures, six of which were directed against the northwestern plateau, although it was probably out of range. The orientation of so many embrasures in this direction appears to confirm that those who reorganised the castle's defences at the end of the thirteenth century judged this plateau to be the point from which any assault would be organised.

Montreal: tower F, plan (after Faucherre)



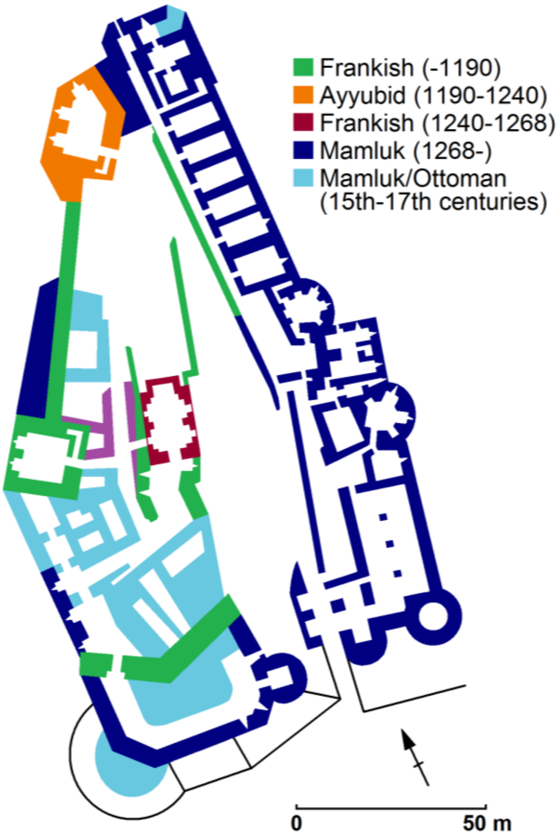
At Shayzar, the Mamluk enlargement of the donjon complex at the southern end of the citadel provided additional embrasures around the pre-existing Ayyubid structure but did little to strengthen it. Extending down the slope, as at Subayba and Montreal, the Mamluk builders added two southward embrasures at the level of the existing Ayyubid ones, two more below in a sub-level and what appear to be four more across an upper level that stretched across the lower Mamluk and Ayyubid structures. While this added more firepower, it did not strengthen the walls, which could be assailed from the town to the west or from the far side of the ditch to the south. The obvious attempt to blend the new masonry with that of the Ayyubids and the addition of an upper

Shayzar: donjon complex, plan (after Tonghini and Montevecchi)



level suggest that there were considerations beyond military ones inspiring this work.[950] The most obvious examples of stronger Mamluk towers are the solid ones at Crac des Chevaliers and Margat.

Beaufort: castle, plan (after Corvisier)



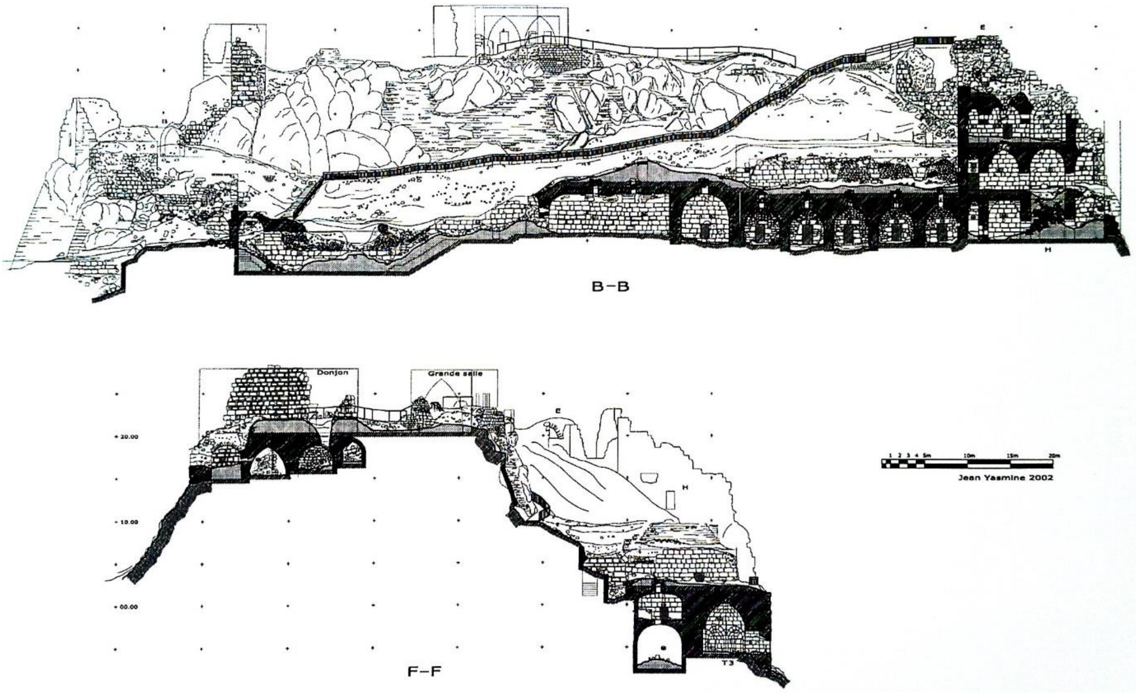
There was no effort to provide lower firing levels in the quadrangular tower that was added to the outer southern wall of Crac. Save a narrow passage servicing a postern and a single internal level, which is more of a gallery built around a central pier, the tower is solid. At Margat, a much smaller rounded tower was built to anchor the outer southern wall where it had been undermined in 1285. Similar to that at Crac, the tower is solid except for an internal gallery, which wraps around a proportionately larger semicircular pillar, just below the roof. While it is possible that these towers might have been built solid in response to the increasing power of artillery, the impressive talus at Margat, from which the tower rises, suggests that mining was considered to be at least as much of a threat. These towers were the most solidly constructed in this region during the Frankish period, but they are also unique in this regard.

In contrast to the solid towers at Crac and Margat, and those bristling with embrasures at Subayba and Montreal, most of the Mamluk additions to Beaufort reveal greater attention to ornamental and residential considerations than militaristic ones. While it would appear that Montreal was still considered to be on a frontier, the additions at Beaufort suggest that this area was quite secure when this building was undertaken.

While certain towers built by Qalawun may have been designed to resist more powerful artillery, fortifications designed under Baybars, like some of those laid out half a century earlier, placed far greater importance on providing liberal numbers of embrasures along exposed fronts. The degree to which Baybars' architects were influenced by the threat of another Mongol invasion of Western Syria, and massed frontal

[950] See Tonghini and Montevecchi, "The Castle of Shayzar," pp. 137-50.

Beaufort: castle, section (from Yasmine)



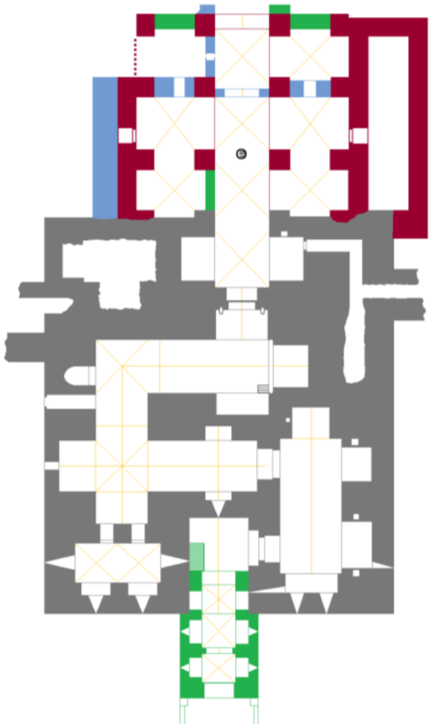
assaults that might accompany this, is unclear. Although there is evidence of increasingly strong counterweight trebuchets from about the 1260s, it remains an important consideration that none of these appears to have effected a breach leading to the fall of a stronghold.[951] These were not the bombards of the fourteenth century nor the early field guns of the late fifteenth. Accordingly, walls were not uniformly thickened and solid towers remained rare. Another indication that artillery was not yet a breaching weapon is the continued development of gateways.

Entrances

A point of fixation among many military historians of the nineteenth century and early twentieth, is the development of bent-entrances. As apertures, gateways were normally weak points in an enceinte, until certain gatehouses were developed to such a point in the fourteenth century that they became the strongest part of certain traces. Such elaborate gatehouses were then rendered superfluous in the sixteenth century with the development of effective siege guns.

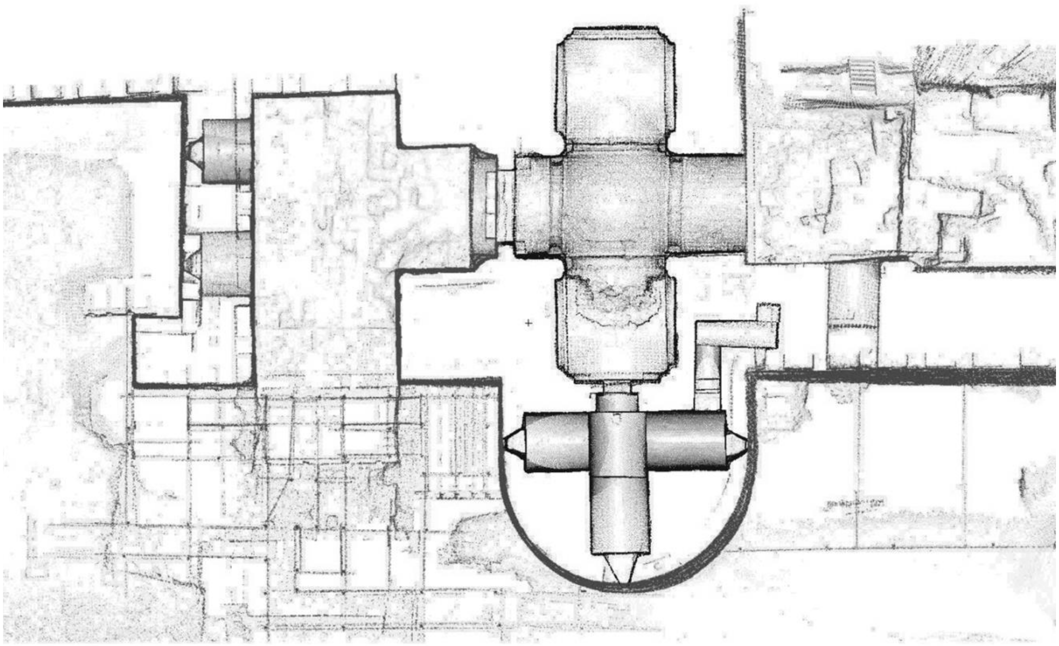
[951] Mufaddal ibn Abi'l-Fada'il's account of the siege of 'Akkar would appear to be an exception, Mufaddal, *Kitab*, ed. and trans. Blochet, 1:532.

Aleppo: citadel gatehouse, plan (after Herzfeld)



The concept of the bent entrance as a means of strengthening gateways had been advocated by classical authors.[952] Although less popular with the Romans than with the Greeks, this style of gateway found use again in the Middle Ages. Twelfth-century Frankish examples of such can be found at Kerak, Montreal, Belvoir, Baghras and the St Stephen's Gate barbican at Jerusalem, while the Bab al-Barqiyya is just one example of Saladin's use of this type of entrance.[953] It would be difficult to explain the increasing sophistication of gateways during this period if it was, as some have suggested, one dominated by the development of curtain-breaching artillery. Instead, the continued development of gateways is another indication that artillery was not as powerful as certain literal readings of the sources might suggest.

Cairo: Bab al-Barqiyya, LIDAR scan (after CyArk)

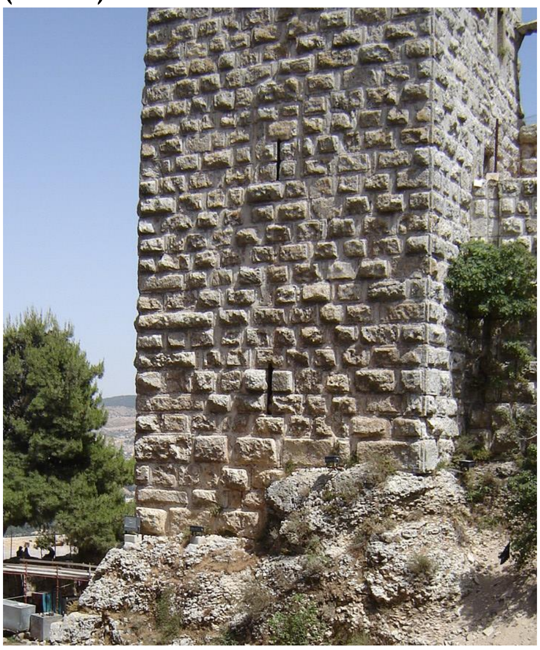


[952] For example, Vitruvius, *De architectura* 1.5.2, ed. Krohn, p. 18, trans. Morgan, p. 22.
[953] For a discussion of the rediscovery of this means of defence, see Creswell, "Fortification in Islam," pp. 101-8. The barbican of St Stephen's Gate is the hardest of these bent-entrances to discern today, for a study of the gate, see Wightman, "The Damascus Gate," 45-60. For gateways and their development in this region more generally, see Yovitchitch, *Forteresses du Proche-Orient*, pp.217-59.

The addition of a bent entrance was one of the first alterations made to 'Ajlun following its original construction,[954] while other Ayyubid examples can be found at Damascus, Baalbek, Bosra, Harim, Apamea, Bourzey, Subayba, Shayzar, Qal'at Najm and Qal'at al-Mudiq. Frankish examples from the early to mid-thirteenth century can be found at 'Atlit, Margat, Caesarea and Tortosa. However, the two most famous entrances from this period are probably the thirteenth-century Hospitaller/Mamluk entrance ramp at Crac des Chevalier and al-Zahir Ghazi's great gatehouse at Aleppo, each forcing anyone attempting to enter to make a number of 90° or 180° turns, totalling 540° in the case of Aleppo. The continued development of gateways by the Mamluks, as at Crac, Beaufort, Safed and Shayzar, confirms the limitations of even the heaviest trebuchets.[955]

Dressing

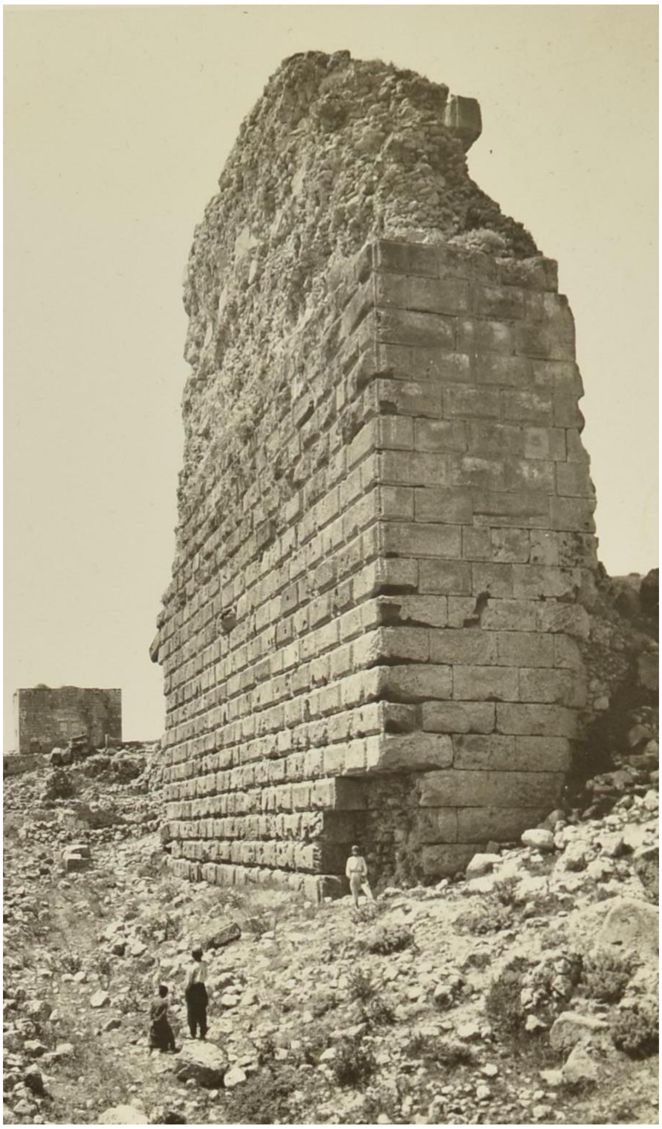
'Ajlun: northeast tower, from the north (author)



While it was wealth that led thirteenth-century fortifications to be built larger and taller, artillery may have had a more subtle influence on design. Some historians have suggested that bossed masonry, which was employed heavily through the twelfth century and early thirteenth, had a defensive purpose.[956] Such arguments assert that by leaving the centre of each block to protrude, it would prevent any incoming projectiles from striking the wall squarely, thus diminishing the percussive force transferred upon collision. If effective, why did this style

[954] Yovitchitch, "The Tower of Aybak," p. 228.
[955] Mamluk examples of gateway development can be seen at castles such as Crac de Chevaliers, Beaufort, Safed and Shayzar.
[956] For example, Chevedden, *The Citadel of Damascus*, p. 274; Nicolle, *Crusader Castles*, p. 52. For bossed masonry generally, see Viollet-le-Duc, *Dictionnaire*, 2:216-18. Studies of masonry dressing began as attempts to date standing architecture in the nineteenth century, Clermont-Ganneau, *Archaeological Researches*, 1:3-46; Conder and Kitchener, *Survey of Western Palestine*, 3:448. For further thoughts on this topic, see Boase, "Military Architecture," p. 143; Benvenisti, *The Crusaders*, p. 384.

'Atlit: northern inner tower, from the north (British Mandate photograph)



of masonry, widely employed by Frankish architects during twelfth century and Ayyubid builders in the early thirteenth, decline in popularity during the thirteenth century as artillery grew stronger?

The theory falls apart when examined more closely. To begin with, most examples of such masonry have relatively flat bosses. This can be seen in cases where small blocks were used, as at Saone, Jubayl, Cursat, Shayzar and Ayyubid Subayba, as well as where mammoth blocks were employed, as at 'Atlit, Montfort, Mamluk Subayba and the Tower of David.[957] More rounded bosses, as can be found in certain areas at 'Ajlun, are rather rare by comparison. The effect of even these would have been negligible when considering that the walls of which they were the final extension were over 2 m thick. Small rounded bosses could have deflected the force of relatively light projectiles but these would have posed little threat the thick walls behind. While it might be suggested that the bosses placed more mass between the point of collision and the back of the wall, this could easily be achieved if the margins of each block were not cut away, preserving a more natural plane.

Hopes that a smoother dressing would deflect projectiles better, given the lower surface friction, may have contributed to the declining use of bossed masonry by the

[957] Similar bossed masonry can be found at a number of European castles in the Bas-Rhin, such as Ottrott (thirteenth-century), Dambach-la-Ville (thirteenth-century) and Wangenbourg (fourteenth-century), and elsewhere at Montréal in Ardèche (thirteenth-century), Chaudenay-le-Château in Côte-d'Or (early-fourteenth-century) and the Narbonnaise gate at Carcassonne (late-thirteenth-century).

Franks in the thirteenth century. Notably, smooth masonry and rounded towers were frequently used together by the Hospitallers, as at Crac, Margat and possibly Arsuf.[958] The Templars continued to employ a range of masonry styles, from the smooth masonry at Chastel Blanc, to the rough work at Baghras, but appear to have favoured the bossed style found at 'Atlit, Tortosa and Sidon.

The use of marginally-drafted ashlar was likely inspired for reasons other than military necessity. Shaping stones this way was cheaper, easier and faster than smoothly dressing each block. The only military consideration might have been one of aesthetics: such rough bosses could disguise the effects of light projectiles, shielding the integrity of the smooth margins and an impression of faultlessness.

Tower Shape

The increasing use of rounded towers in the thirteenth century has also been linked to the increasing power of artillery. The defensive advantages of such a design had been recognised in antiquity: Vitruvius had extolled the virtues of round towers against mining, rams and other machines and Ammianus identified the weakness of rectangular towers in his account of Julian's siege of the Assyrian town of Pirisabora.[959] Some modern scholars have amended these sentiments and suggested that the greater use of round towers in the thirteenth century was influenced by their ability to deflect artillery fire.

In attempting to explain the shift towards rounded towers, Kennedy has suggested that the weakness of quadrangular towers was two-fold: the susceptibility of their corners to mining, and the shelter that they provided at the base of their outward face, which allowed sappers to work in relative safety.[960] While the former would appear to have been inspired by our classical commentators, the latter is suited better to the Early Modern period and systems of polygonal defences. Although both have merit, neither is sufficient

[958] It is possible that the defences of Arsuf predate the castle's acquisition by the Hospitallers; however, they would appear to postdate 1240, see Ewart, et al., "Dundonald Castle Excavations," pp. 130-41.
[959] Vitruvius, *De architectura* 1.5.5, ed. Krohn, p. 19, trans. Morgan, p. 23; Ammianus, *Res gestae* 24.2.9-12, ed. Eyssenhardt, pp. 298-99, trans. Younge, pp. 351-52.
[960] Kennedy, *Crusader Castles*, p. 114.

to explain why beaked or pentagonal towers, which were simpler to construct, were not adopted instead.[961]

Rounded towers had been used frequently by the Romans and continued to be a fixture in Byzantine architecture. They were subsequently adopted in Muslim building at a time when the construction of stone fortifications experienced a hiatus in much of Europe. Before the First Crusade, rounded towers were built by the Armenians in Cilicia and were used to flank the eleventh-century Bab al-Futuh in Cairo.[962] The earliest examples of rounded towers at a Frankish castle appear to be those along the eastern wall of Saone, although these may rest on earlier foundations, and are virtually the only examples of such until the early thirteenth century.[963] Throughout the twelfth century, most Frankish towers were quadrangular, similar to those built in Latin Europe.[964] Quadrangular towers were simple to construct and provided a convenient internal space to inhabit. Although more complicated to build, rounded towers provided a better field of view and distributed structural weight more evenly. Rounded towers became increasingly popular during the thirteenth century but did not replace quadrangular towers completely. The latter were regularly built by the Templars and were used exclusively at Caesarea by Louis IX, despite his use of round towers elsewhere, as at Aigues-Mortes.

Al-'Adil experimented with large-angular plans at Harran in the late twelfth century but abandoned these for more simple quadrangular layouts in the early thirteenth. Although the Mamluks appear to have preferred quadrangular towers in most cases, rounded towers were built at Subayba, Safed, Crac and Margat. The continued and frequent use of quadrangular towers through the thirteenth century, especially in Muslim

[961] Towers of this shape have precedent in antiquity, such as those at Salona, and were adopted to a degree by Frederick II in Italy.

[962] For the most comprehensive study of Armenian fortifications in Cilicia, see Edwards, *The Fortifications of Armenian Cilicia*. For the Armenian-built gates of Cairo, see Creswell, "Fortification in Islam," pp. 113-19.

[963] The rounded towers at Baghras may be another rare example of twelfth-century rounded towers built by the Franks; however, the dating of these towers is unclear and it cannot be said with certainty that they were not built after 1188, either by the Armenians or by the Templars.

[964] Anglo-French examples of circular or near-circular large-angular towers include the keeps of Arundel, Windsor, Cardiff, Carisbrooke, Tonbridge, Tickhill, Chilham, Odiham, and Château-sur-Epte as well as the enclosure around the keep of Farnham. More developed circular keep-towers date from the reign of Henry III in England and Philip II in France. For some of these early towers, see Colvin, ed., *The History of King's Works*, 1:75-78. Experimentation with rounded forms can be found at Provins, Houdan, Etampes and Gisors in France as well as Orford, Conisbrough and Longtown in England. By the thirteenth century, notable circular keeps were built at Coucy, Pembroke, Bothwell, Dourdan, Villeneuve-sur-Yonne, Aigues-Mortes and Flint, some similar to the large keep tower built by Baybars at Safed.

architecture, is a strong indicator that the threat of artillery was not a significant incentive to build round towers.

Hugh Kennedy has suggested that the more widespread adoption of round towers in Europe, at least in England and northern France, was in part linked with the crusades.[965]

> [I]t is likely that the use of trebuchets and possibly mining were originally learned during the Crusader wars. Certainly Richard I used men from the Crusader states among his artillery men. It is not surprising therefore, that the architects of defensive works adopted some similar designs to thwart these new methods of assault.[966]

However, mining had been undertaken by the Franks at Nicaea in 1097, their first siege in the Near East, and the artillery that Richard I employed at Acre in 1191, which he had prepared ahead of time on Cyprus, appears to have been at least as powerful as that of Saladin. Furthermore, there is no dramatic change in the way that the chroniclers deal with the artillery used by these men in Europe when they returned.[967] Lastly, rounded towers had been built by both Richard I and Philip II in Europe before they went on crusade, while rounded towers survived in certain town walls dating to the Roman period.

There is little to support a direct link between the increased use of round towers and the emergence of counterweight artillery, despite the chronological correlation. At best there are circumstantial indications that some rounded towers might have been designed with artillery in mind. The southern faces of the three towers at the south end of the inner defences of Crac are rounded, while their interior levels, except the topmost of the western tower, are quadrangular. The towers rise from the glacis so considerations other than mining or rams would have inspired the shape of these towers. Similarly, the interior of the circular donjon at Margat is laid out in a rectangle. It may have been hoped that the rounded exteriors of these towers would deflect any incoming projectiles and that the flat outward face inside, aligned perpendicularly to where artillery would most likely be positioned, would maximise the thickness of the wall. On the other hand, the exterior

965 In general, rounded towers became the preference of both Philip II and Richard I by the end of the twelfth century and by the close of the thirteenth most mural towers financed by the French and English crowns, as well as those in Italy by the Holy Roman Emperor, were rounded.

966 Kennedy, *Crusader Castles*, pp. 186-87.

967 Although William the Breton's account of Philip's siege of Chateau Gaillard in 1203-4 is often referenced to support the use of new heavy artillery, the poetic style of the account and lack of corroborating evidence provided by contemporary sources leaves this in doubt, William the Breton, *Philippide* 7, pp. 179-208. Cf. Roger of Wendover, *Flores historiarum*, ed. Hewlett, 1:317-18, 2:8, trans. Giles, 2:207-8, 213; Rigord, *Gesta Philippi Augusti* 141, p. 159.

plan might have been inspired for other reasons, such as aesthetics, while the quadrangular interior allowed for the use of simple barrel vaults.

It is hard to claim that any architectural shifts of the twelfth and thirteenth centuries were a direct result of considerations relating to heavier offensive artillery. Although there is circumstantial evidence of such, most that predates the 1280s is unpersuasive. But another shift in tower-design has not yet been discussed: the appearance of extremely large quadrangular towers in the opening decades of the thirteenth century. Among the explanations for the design of these towers, Paul Chevedden has argued that many of them were not only meant to resist the heaviest counterweight trebuchets but also to support them.

9. Defensive Artillery and Artillery Towers

Throughout the crusades, it appears that artillery was used as frequently by defending forces as it was by attackers. Latin forces encountered defensive artillery from the time of the First Crusade; however, both Franks and Muslims were almost certainly well aware of the value of utilising artillery in this way before the crusaders set out. In 1102, Robert of Bellême is said to have strengthened his castles against Henry I by supplying them with *machinae*, possibly traction trebuchets.[968] In the same year, the defenders of Isfahan (in modern Iran) prepared artillery ahead of Sultan Barkyaruq's siege of that place.[969] In the following decades the effective use of defensive artillery is highlighted by the sources on a number of occasions. It was used by the Muslim defenders of Beirut in 1110,[970] the Franks defending Jaffa in 1115,[971] and at the Muslim defence of Tyre in 1124.[972] Such engines remained important weapons for defenders throughout the twelfth and thirteenth centuries.

In the early twentieth century, Hamilton Thompson, commenting on medieval England, concluded that against the great offensive artillery, the besieged were all but powerless as it was impractical to employ the same type of engines in a defensive role.

> The use of such machines upon the walls themselves was as dangerous to the stability of the masonry as their use by the enemy, and hastened the chance of a breach: they could not be employed from the interior of the enclosure, without endangering the defenders on the rampart. The summit of the rectangular keep of the twelfth century was never constructed as a platform for artillery: here again, engineers probably feared the effect of the constant vibration upon a flat wooden roof, and were content to conceal their ridged roofs within high ramparts.[973]

[968] John of Worcester, *Chronica chronicarum*, ed. and trans. McGurk, 3:100-1; Roger of Howden, *Chronica*, ed. Stubbs, 1:159, Walter of Coventry, *Memoriale*, ed. Stubbs, pp. 120-21.
[969] Ibn al-Athir, *al-Kamil*, trans. Richards, 1:53.
[970] Ibn al-Qalanisi, *Dhail*, trans. Gibb, p. 99-100.
[971] William of Tyre, *Chronicon* 11.24, ed. Huygens, 1:531-32, trans. Babcock and Krey, 1:502-3.
[972] William of Tyre, *Chronicon* 13.6, ed. Huygens, 1:593-94, trans. Babcock and Krey, 2:10-11. For further examples, see Appendix 2.
[973] Thompson, *Military Architecture*, pp. 77-78.

Although apparently ignoring the wealth of source evidence supporting the use of defensive artillery, Thompson keenly identified the impracticality of mounting heavy artillery on top of most medieval towers, a limitation which is chronically overlooked.

While the utility of defensive artillery is emphasised at certain sieges, it is possible to overstate its significance. For example, Ibn al-Athir claims that al-Lawba (in the Biqa') fell to Shams al-Muluk of Damascus in 1132 because its defenders failed to erect defensive artillery,[974] and Hugh Kennedy suggests that the defenders of Kerak suffered as a result of their inability to erect a defensive engine in 1183.[975] It is hard to discern the effect that artillery might have had at al-Lawba and equally unclear how Kerak suffered by not having any in 1183 – Saladin appears to have been no more successful in 1183 than when both sides employed artillery during the siege of the castle the following year.[976] Taking matters to an extreme, David Nicolle has not only highlighted the potential effectiveness of tower-mounted defensive artillery, but claims that this was how the counterweight trebuchet was most successfully employed.[977]

Analysing the thirteenth century, Christopher Marshall has identified the importance of defensive pressure, including the use of ballistic engines, as Frankish strategies of defence evolved.[978] Artillery appears to have been used relatively effectively at 'Atlit (1220), Beaufort (1268), 'Akkar (1271) Margat (1285) and Acre (1291), despite the ultimate capture of all but 'Atlit. As an important feature of both Muslim and Frankish defensive measures, it remains to investigate more closely these defensive engines and how they were used.

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[974] Ibn al-Athir similarly states that the Damascenes were allowed to take al-Lawba in 1132 because its garrison failed to erect defensive artillery in time, Ibn al-Athir, *al-Kamil*, trans. Richards, 1:296.
[975] Kennedy, *Crusader Castles*, pp. 117-18.
[976] For sieges of Kerak in 1183 and 1184, see Chapter 4.
[977] Nicolle, *Crusader Castles*, pp. 44, 59.
[978] Marshall, *Warfare in the Latin East*, p. 238. The effectiveness of this practice was not confined to the East. Roger of Wendover, for example, describes how the baronial party that invested Mountsorel on behalf of Henry III was restrained by defensive fire from the garrison in the spring of 1217, allowing the castle to be relieved by Prince Louis. He also highlights the prominence of such engines during the two-week defence of Avignon in 1266 before the city fell to treachery, Roger of Wendover, *Flores historiarum*, ed. Hewlett, 2:208-9, 211, 309-10, trans. Giles, 2:389, 391, 478-79. For further instances in which artillery was employed defensively, see Appendix 2.

Ground-mounted Artillery

Most of the defensive artillery employed by the Muslims during the First Crusade may have been situated on the ground. References such as Fulcher of Chartres' to the garrison of Antioch's use of *petrariae* and *fundabula* to throw decapitated heads out of the city, appear to imply that these engines threw their projectiles over the town walls rather than from them.[979] Similarly, Albert of Aachen and William of Tyre seem to distinguish between the positions where defensive engines were placed and where the defenders were positioned along the battlements during the Provençal push against Antioch's Bridge Gate.[980] At Jerusalem, Albert of Aachen and Ralph of Caen claim that when the defenders moved the artillery with which they were targeting the northern siege tower, they encountered difficulties repositioning these engines and then firing them in the tight urban constraints.[981] Although Albert and Ralph were not at the siege, their assertion that the defending engines were on the ground behind the walls may reflect eyewitness testimony or perhaps a practice familiar to them. William of Tyre similarly places the artillery that defended Jerusalem in 1099, as well as that which defended Tyre in 1124, inside the city.[982]

As offensive weaponry developed so too did that of defenders. If counterweight trebuchets were employed by attacking forces by the 1180s, even if they were quite small, it is possible that engines of a similar scale were used defensively. Although they fired at a slower rate than traction trebuchets, counterweight engines had a longer range and were more accurate. If placed behind a curtain wall, a counterweight trebuchet could target attacking artillery of a similar scale or approaching siege engines from a position of relative security, as appears to be shown in **Fig. E1**. A spotter on the parapet could recommend adjustments for range. It is possible that engines such as *Mala Cognata*/*Male Cosine*, which targeted Philip II's notable trebuchet from inside Acre in 1191, and one or

[979] Fulcher of Chartres, *Historia Hierosolymitana* 1.15.10, ed. Hagenmeyer, p. 221, trans. Ryan, p. 94.
[980] Albert of Aachen, *Historia Ierosolimitana* 3.41, ed. and trans. Edgington, pp. 202-5; William of Tyre, *Chronicon* 4.15, ed. Huygens, 1:254-56, trans. Babcock and Krey, 1:210-11. For the siege of Antioch in 1097-98, see Chapter 3.
[981] Albert of Aachen, *Historia Ierosolimitana* 6.17, ed. and trans. Edgington, pp. 424-25; Ralph of Caen, *Gesta Tancredi* 123, RHC Oc 1, p. 691, trans. Bachrach and Bachrach, p. 139. For the siege of Jerusalem in 1099, see Chapter 3.
[982] William of Tyre, *Chronicon* 8.13, 13.6, ed. Huygens, 1:403-4, 593-94, trans. Babcock and Krey, 1:361-63, 2:10-11. For the siege of Tyre in 1124, see Chapter 4.

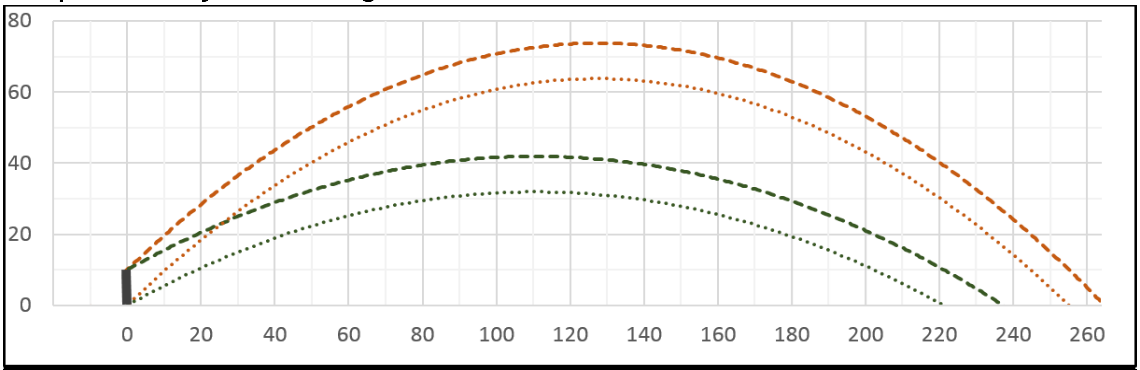
more of the nine which defended Mosul in 1182 were counterweight trebuchets.[983] The comparative exposure of offensive engines is clear in both of these examples, and is vividly described by Ibn al-Athir at the siege of Bourzey in 1188.[984]

Baybars had the unique opportunity to assail a castle from within another stronghold when he besieged Beaufort in 1268. Lighter engines may have been erected on the towers of the Templar outwork, had there been room for them, but the heavier engines, much larger and more costly, were probably set up on the ground inside the enclosure. Heavy artillery appears to have been used by the Franks to defend Margat in 1285 and Acre in 1291. These seem to have been well concealed as they enjoyed relative security throughout both sieges. This was certainly true of the Pisan engine at Acre, which was at some distance from the curtain near the church of St Romanus in the Gardens. Such examples appear to confirm that the heaviest offensive engines that were stored in a stronghold could be used to defend it if need be, and that such engines were generally placed on the ground.

The horizontal range gained by elevating an engine will always be less than the distance that the engine is raised if it fires at an angle of 45° or greater.[985] By comparison, the horizontal distance sacrificed backing up an engine, allowing it to fire over the parapet from the ground, causes a greater relative loss to range than its elevation. However, it is important to bear in mind that accuracy decreases with range: by extending the flight time, environmental and mechanical discrepancies from shot to shot are amplified. Furthermore, the longer a projectile is in the air, the more time a mobile target has to avoid it.[986]

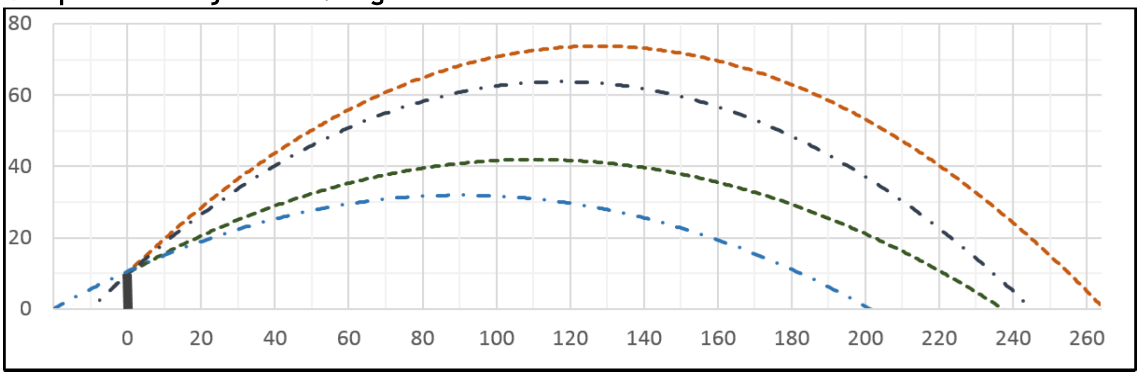
[983] See Ambroise, *Estoire* 5, l. 4,746, ed. Paris, p.127, trans. Ailes, 98; *Itinerarium* 3.7, ed. Stubbs, p. 218, trans. Nicholson, pp. 208-9; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:285-87.
[984] Ibn al-Athir, *al-Kamil*, trans. Richards, 2:286, 350.
[985] For example, if an engine fires two shots at 45°, but the second at an elevation 20 m higher than the first, the second shot will travel only 18.6 m farther if both are fired at a velocity of 50 m/s. If travelling at a velocity of 25 m/s, the second shot will land only 16 m farther.
[986] A projectiles fired at about 50 m/s might achieve a range of 250 m, but would be subject to a flight time of over seven seconds.

Comparable Trajectories: Engines on a Tower and at the Base of a Wall



Position	Horiz. Pos.	Vert. Pos.	Velocity	Release Angle	Max. Range
Tower	0 m	10 m	50 m/s	45°	264.7 m
Ground	0 m	0 m	50 m/s	45°	255.1 m
Tower	0 m	10 m	50 m/s	30°	237.1 m
Ground	0 m	0 m	50 m/s	30°	220.9 m

Comparative Trajectories: Engines on a Tower versus Behind a Wall



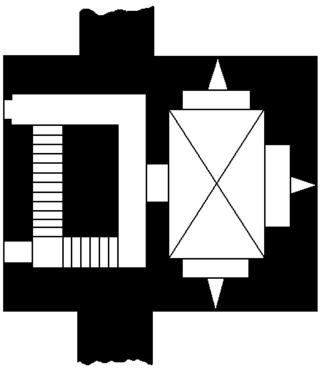
Position	Horiz. Pos.	Vert. Pos.	Velocity	Release Angle	Max. Range
Tower	0 m	10 m	50 m/s	45°	264.7 m
Ground	-10 m	0 m	50 m/s	45°	245.1 m
Tower	10 m	10 m	50 m/s	30°	237.1 m
Ground	-20 m	0 m	50 m/s	30°	200.9 m

Besides issues of exposure, occupying an elevated platform with a large trebuchet denied this position to lighter engines, archer and slingers, which were all more effective in an antipersonnel capacity. Even the smallest counterweight trebuchets have a reasonably significant footprint due to the necessity of outriggers, required to provide lateral support and ensure that the forces created by the swinging counterweight remained as two-dimensional as possible. The forces unleashed by the falling counterweight posed a risk to anyone standing too close if a problem were to arise, while the long beam and sling required space in front and behind the engine to move unobstructed. Whereas little performance was compromised by placing such engines on the ground behind the curtain, more versatile antipersonnel forces were of little use in such a position. Additionally, any tower intended to carry a counterweight engine would not only have to support the weight of the engine, but also the dynamic forces that were created during the firing sequence. Accordingly, towers capable of supporting the heaviest counterweight trebuchets do not appear to have been built until the end of the thirteenth century. Lighter artillery, however, had been mounted on towers long before the First Crusade.

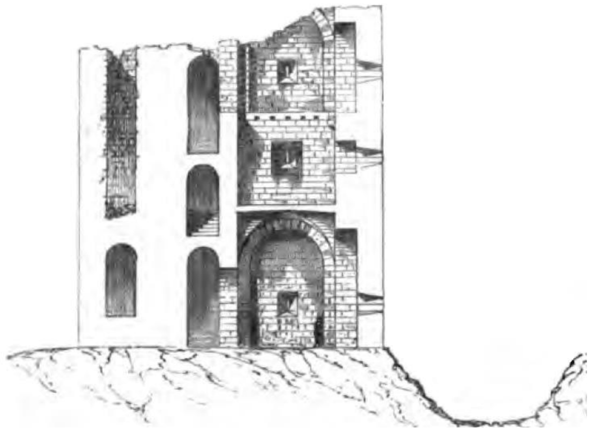
Tower-mounted Artillery

Evidence dating back to the fourth century BC suggests that some Greek towers were designed specifically to incorporate torsion bows.[987] In the first century BC, such machines influenced Vitruvius's theories concerning the optimal spacing of mural towers.[988] The engines considered by Vitruvius do not appear to have been significantly heavy, as the weight of defending cohorts is the largest mass that he includes when dealing with fortifications.[989] Heavier *onagers* are mentioned in a defensive capacity by Ammianus at the Persian siege of Amida in the fourth century and by Procopius at the Gothic siege of Rome in the sixth.[990] However, Ammianus also warns against using such engines on top of defensive ramparts, as the shock created when firing an *onager* (*scorpio*/*tormentum*) would threaten the masonry below.[991] With this in mind, Peter Purton has suggested that repeated efforts to strengthen the walls of Rome up to the sixth

Antioch: mural tower, plan (after Rey)



Antioch: mural tower, section (from Rey)



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987 Ober, "Early Artillery Towers," pp. 569-604; Ober, "Towards a Typology," pp. 147-69.
988 Vitruvius, *De architectura* 1.5.4, ed. Krohn, p. 18, trans. Morgan, pp. 22-23.
989 Vitruvius, *de architectura* 1.5.3-8, ed. Krohn, pp. 18-20, trans. Morgan, pp. 22-24
990 Ammianus, *Res gestae* 19.7.7, trans. Younge, p. 197; Procopius, *Wars of Justinian* 5.21, ed. and trans. Dewing, 3:204-7.
991 Ammianus, *Res gestae* 23.4.4-7, ed. Eyssenhardt, pp. 270-71, trans. Younge, pp. 322-23.

century may reflect efforts to mount increasingly heavy defensive artillery, rather than attempts to resist more powerful offensive engines.[992] If this was the case, it stands to reason that the rebuilding work carried out at Antioch by Justinian would have followed a similar model. Perhaps this is why the city's mural towers appear better suited to support a significant mass at their top level than the vast majority of towers built by the Franks and Muslims during the twelfth and thirteenth centuries.[993] Intended or not, this ability came through the solid pier in the back half of these towers, around which the internal staircases were wrapped. But towers capable of bearing such significant loads, as could have been supported by the piers in these towers, were not often necessary.

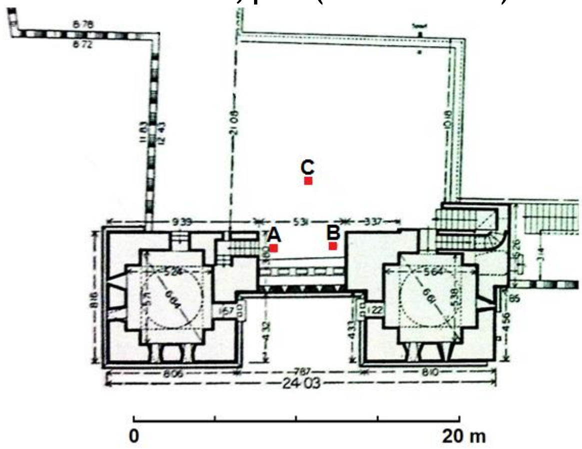
Although the Muslims may have placed their defensive artillery on the ground at the time of the First Crusade, light traction trebuchets were certainly elevated by the end of the century. Mounting such engines on top of towers not only augmented their range but also provided crews with a better field of fire and added velocity to their projectiles when striking targets below their initial elevation. It was likely such engines that George Palaeologus placed along the walls of Durazzo, according to Anna Comnena, in expectation of the Norman siege in 1081, and that Ibn al-Athir notes were installed on the walls of Jerusalem ahead of Saladin's siege in 1187.[994] It has even been hypothesised that some of the spurs surrounding Li Vaux Moise (al-Wu'ayra) may have supported some type of light artillery in the twelfth century,[995] although there are no indications of this in Ibn Muyassar's account of the eight-day Egyptian attack in 1158.[996] It would have been similar traction trebuchets that Ibn 'Abd al-Zahir claims were erected on the walls of Tarsus, when it revolted in the ninth century, and that were set up by the Franks along the defences of Jaffa in 1266.[997] So too would have been the engines prepared along the walls of Alexandria in 1272-73, and those that Rashid al-Din claims were erected on the walls of Baghdad in response to increasing Mongol pressure.[998]

A number of illustrations confirm that traction trebuchets were mounted on towers.[999] With an eye to this, Creswell identified three indents in the platform over Bab

[992] Purton, *Early Medieval Siege*, p. 16.
[993] Towers built by Justinian with a similar plan can be found along the northern and southern walls of Zenobia (Halabiyya), see Lauffray, *Halabiyya-Zenobia*, vol 1.
[994] Anna Comnena, *Alexiad* 4.1, trans. Sewter, p. 135; Ibn al-Athir, *al-Kamil*, trans. Richards, 2:330.
[995] Marino, et al., "The Crusader Settlement in Petra," pp. 8-9.
[996] Ibn Muyassar, *Akhbar Misr*, RHC Or 3, p. 472.
[997] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:590, 795-96.
[998] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:830; Rashid al-Din, *Ta'rikh-I Ghazani*, trans. Boyle, pp. 190, 232-33.
[999] See **Figs. B2**-**B10**, **B22** and **B23**.

al-Nasir, Cairo, which he believed may have been created to support the legs of a stone-thrower, perhaps similar to those depicted in Peter of Eboli's manuscript.[1000] While there is plenty of illustrative evidence that confirms that traction trebuchets were placed on towers, very few illustrations depict towers supporting counterweight trebuchets.

Cairo: Bab an-Nasr, plan (after Creswell)



Rather than occupying such an ideal vantage point with a powerful but cumbersome counterweight trebuchet, a rapid-firing traction trebuchet, which could be yawed much more easily, would have been very effective if placed on a tower. Such engines could be used against faster moving targets and attacking troops. Although traction engines were less powerful, they proved capable of disabling siege towers if given enough time, as at Jerusalem (1099) and Beirut (1110); however, large immobile targets were better suited to a counterweight trebuchet, as may have been used at Mansura in early 1250.

<u>Mounting Counterweight Artillery</u>

It is unfortunate that no architectural study has been conducted to test the limits of how much additional weight most medieval towers could support. But a tower intended to carry a counterweight trebuchet also had to deal with dynamic forces: there was not only the weight of the engine to support but also the angular forces generated by the falling counterweight and its subsequent swinging. These stresses would have been immense. If the beam of *Arrangement A* is loaded to 135°, the massive 10,000 kg counterweight will contain 250,000 J of potential energy and the subsequent 3.4 m fall will generate up to 98,000 N and 333,200 kg m/s (N s) of momentum. Although the projectile and 2,000 kg beam, would decrease these values, this is an enormous amount of energy to be transferred through the course of the firing sequence; this is also a very large engine. If *Arrangement B* is considered, the counterweight holds 16,700 J of potential energy and

[1000] Creswell, *Muslim Architecture*, 1:166-76.

falls with 9,800 N of potential force and 16,660 kg m/s (N s) of momentum, once again slightly mitigated by the masses of the projectile and beam.[1001]

The masonry supporting a counterweight trebuchet is subject to considerable uniaxial compression, a force which is magnified as energy is shifted to restrict the fall of the counterweight. But as the counterweight begins to swing beneath the axle, the direction of force becomes two dimensional, compelling the supporting masonry to contend with shear stresses. Although a fixed counterweight would allay some of the extra downward force created by the falling mass, relative to a comparable hinged model, it would also amplify the subsequent swinging due to the greater inefficiency of this mechanical system. Despite the challenges to modelling these forces, and then to correlate the findings with examples of towers built with various materials and different designs, such a study might reveal at what point and in which regions it may have been possible to mount counterweight trebuchets on towers.

Without conducting such a study, Paul Chevedden argued, in his 1986 PhD thesis, that the large towers built by al-'Adil at the citadel of Damascus were designed to carry just such engines. Although he addresses issues such as the space required by such engines, he fails to consider the structural strains that they would create. It has already been shown that the heaviest counterweight trebuchets were much less powerful at the start of the thirteenth century than Chevedden has suggested; however, it remains to investigate if there is evidence to indicate that any towers were designed to carry counterweight artillery. In the absence of a more quantitative architectural study, indications that towers were designed to withstand considerably greater forces than might otherwise be necessary will be examined instead.

Possible Ayyubid Artillery Towers

Chevedden has explained the near spontaneous appearance of large towers following Saladin's death, typified by those built by Saladin's brother, al-'Adil, and son, al-Zahir Ghazi, as the response to a need to mount heavy counterweight trebuchets on top of

[1001] The retarding effect of the beam's mass might be sufficient to slow the end of *Arrangement A*'s long arm almost 6 m/s and that of *Arrangement B* by over 3 m/s, if each beam rotated 90° and released its projectile at 45°.

towers. This, he argues, was necessary to offset a supposedly enormous advantage held by offensive artillery.[1002] With no evidence to indicate the introduction of an outside element, such as a foreign technology, Chevedden has suggested that the appearance of these large towers was a delayed reaction to the more general advancement of offensive weaponry.

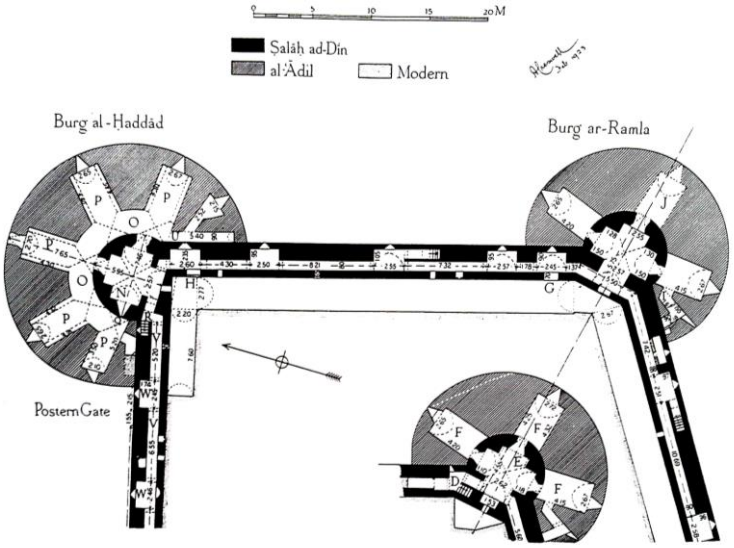
The towers built by Saladin at Damascus and Cairo are relatively small, comparable to those constructed by Nur al-Din. This would appear to imply that such towers were judged to be sufficiently strong at a point when counterweight trebuchet technology was known.[1003] Descriptions of the siege of Acre suggest that such engines may have been employed there in 1190-91, but confirm that these were neither effective breaching engines nor considered to be technologically new or special. The casual manner in which the various sources discuss the Western and Eastern artillery and their failure to distinguish between them indicates that neither side held a technological advantage.[1004] Collectively, this suggests that the artillery that influenced the design of al-'Adil's towers, was probably only marginally more powerful than that which would have been considered by Saladin's architects.

Al-'Adil's Early Work

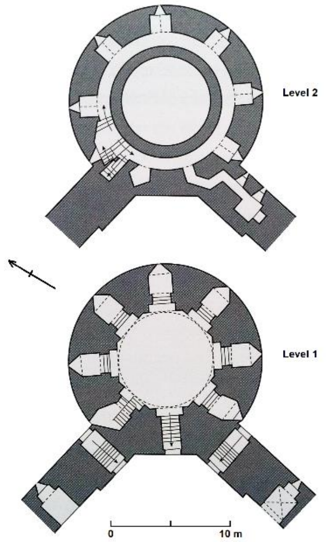
In the mid-1170s, Saladin embarked on an ambitious building campaign to fortify Cairo, constructing a new citadel between the new and old cities. The scale of these defences impressed Ibn Jubayr when he viewed them in the spring of 1183, a year ahead of their completion.[1005] The citadel was then developed by al-'Adil, who added at least three, and as many as six, large quadrangular towers and encased some of the round towers, notably Burj al-Haddad and Burj ar-Ramla, within much larger round towers. The two brothers' work is easily distinguishable by style and scale: Saladin's larger towers, such as Burj al-Zafar, are comparable in scale to other large twelfth-century towers, while al-'Adil's, completed around 1207-8, are much larger; while the defences built by Saladin are of

[1002] Chevedden, *The Citadel of Damascus*, esp. pp. xliii-xliv, 7-8. For a poor analogy between the supposed architectural response to artillery in the early thirteenth century and that at the start of the Early Modern period, in response to the early employment of effective siege guns, see Chevedden, "Invention," p. 73.
[1003] For illustrative proof of this knowledge by the 1180s, see **Fig. C1**.
[1004] For the siege of Acre in 1189-91, see Chapter 5.
[1005] Ibn Jubayr, *Rihla*, trans. Broadhurst, p. 43. For the dating, an inscription over the Bab al-Mudarraj dates it to 570 [1183-84]. Cf. Ibn al-Athir, *al-Kamil*, trans. Richards, 2:249.

Cairo: eastern towers of the citadel (from Creswell)



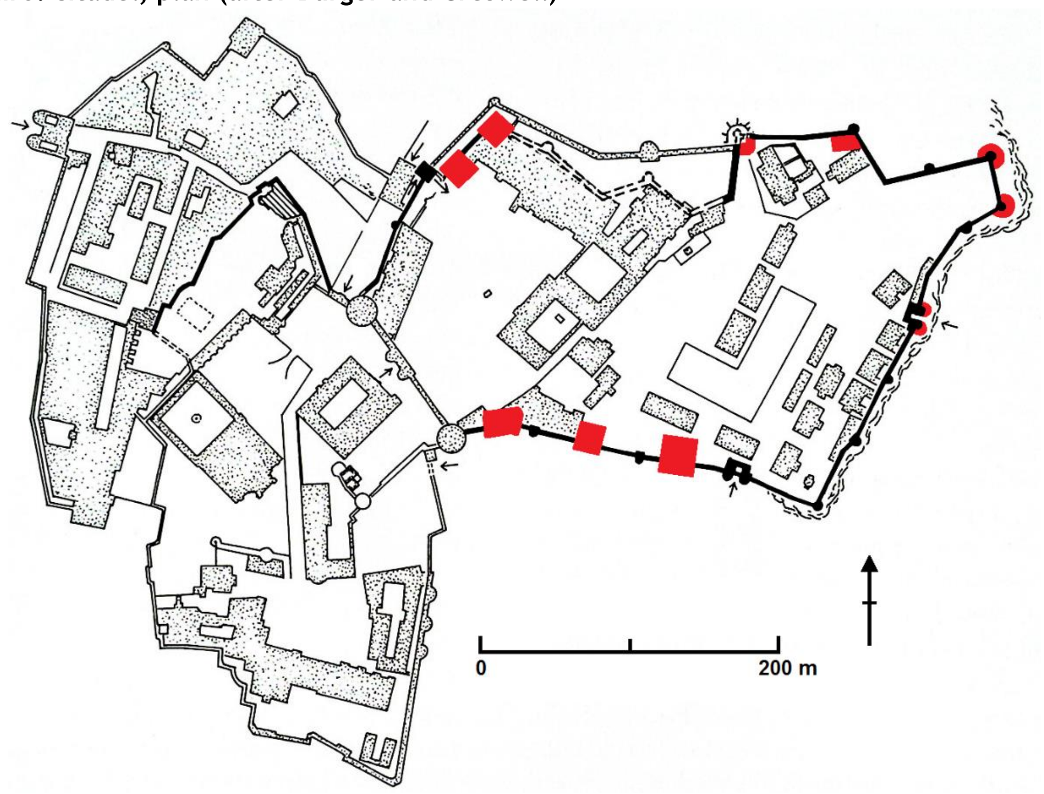
Cairo: Burg al-Zafar (after Yovitchitch and Creswell)



smooth masonry, those of al-'Adil are much rougher.[1006] These, however, were not the first fortifications built by al-'Adil.

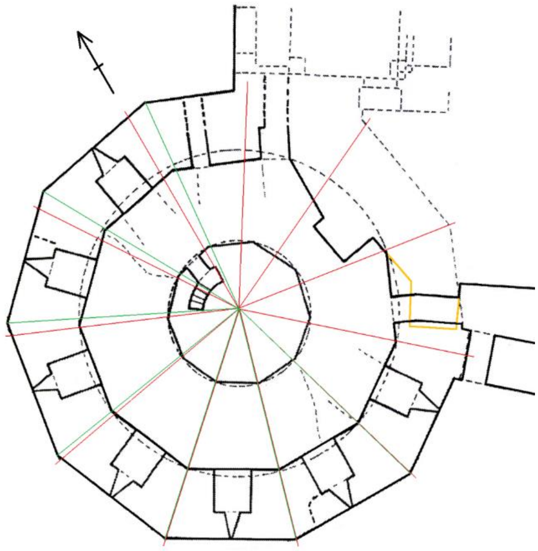
Late in Saladin's reign, al-'Adil constructed a quadrangular citadel at Harran with an eleven-sided tower, nearly 30 m in diameter, at each corner. Each of the three surviving towers has a different internal layout and evidence of what were once three internal

Cairo: citadel, plan (after Burger and Creswell)

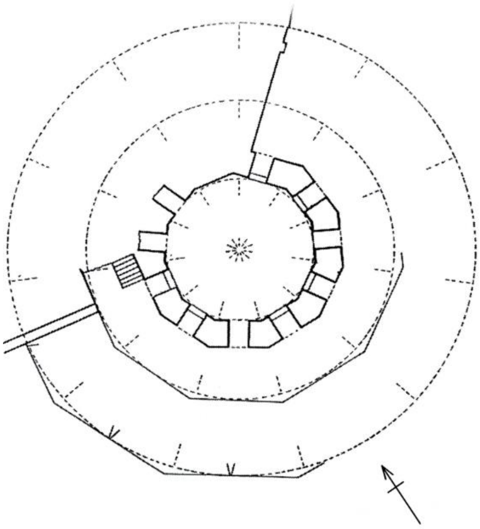


[1006] Al-Maqrizi, *al-Suluk*, trans. Broadhurst, p. 151. Cf. Creswell, "Fortification in Islam," pp. 121-23; Boase, "Military Architecture," pp. 150-51.

Harran: west citadel tower, plan with hendagonnal overlay (after Hanisch)



Harran: south citadel tower, plan (after Hanisch)



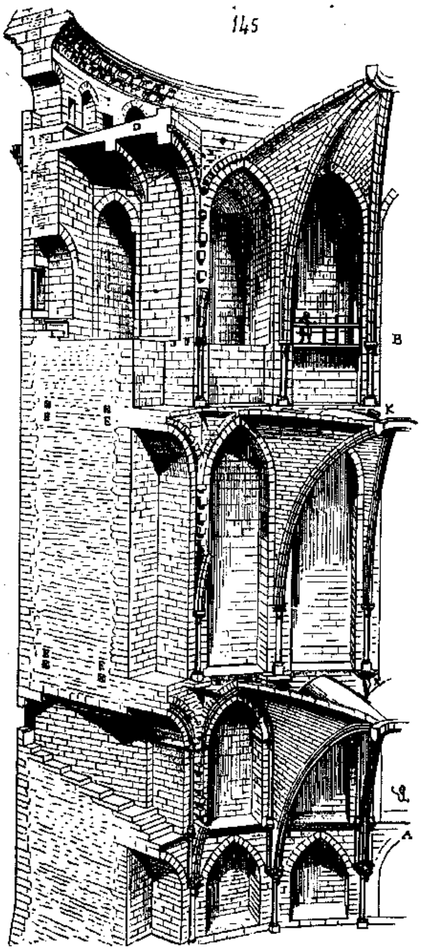
levels.[1007] The scale of these towers is reminiscent of those built later at Cairo, but their shape is quite different and the varying internal plans may suggest that some degree of experimentation was taking place. The internal structures of the southern and western towers are the clearest.

Inside the southern tower, there is an eleven-sided structure laid out to mirror the angles of the outer wall. There is an aperture in each face of the internal structure at the first level and every other face at the level above. In the centre of the western tower, there is a central ten-sided pillar that contains a winding staircase. The outer walls of the towers appear to have been more than 3 m thick and the central structures would suggest that they were able to bear significant vertical loads; however, Hanisch has argued the opposite.[1008] While the open space within the inner structure of the south tower was a weakness, Hanisch suggests that the ten-sided central pier in the west tower would have unevenly distributed the weight of the vaulted ceilings. Furthermore, at the first and third levels (ground and second floors), casemates were inserted into each of the outer faces while at the second level these were positioned in the tower's angles. Staggering the casemates would have provided a better field of fire and minimised vertical seams of thinner masonry, rendering the walls more cohesive and resilient to undermining. However, aligning the casemates would have created vertical piers of masonry that may have allowed the tower to support greater vertical loads.

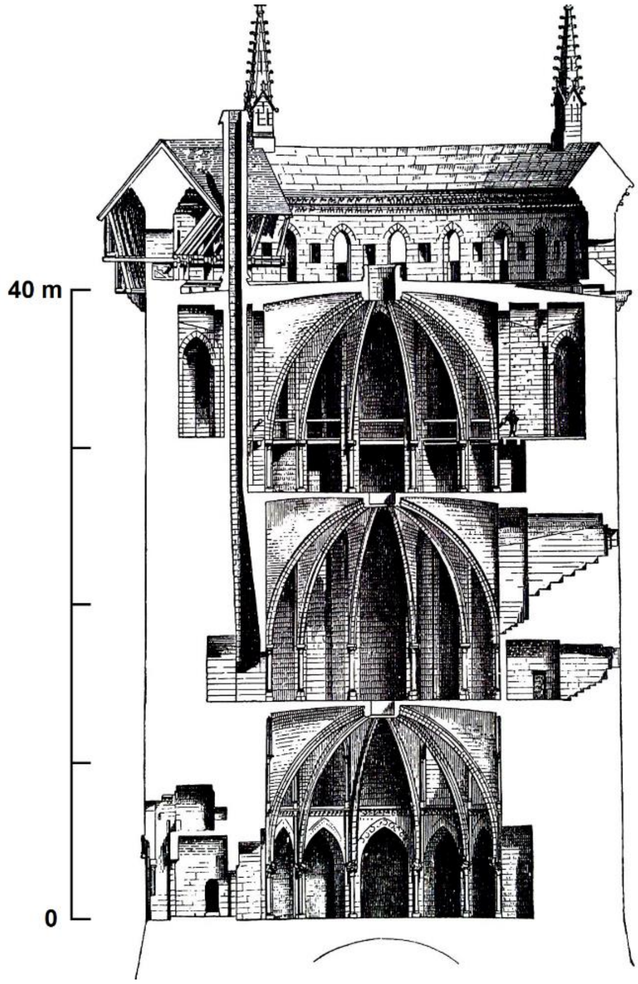
[1007] Hanisch, "The Works of al-Malik al-'Adil," pp. 168-74. Cf. Lloyd and Brice, "Harran," pp. 77-111.

[1008] Hanisch, "The Works of al-Malik al-'Adil," pp. 168-74. Hanisch does not relate these issues to any consideration of artillery.

Coucy: donjon, cutaway (from Viollet-le-Duc)

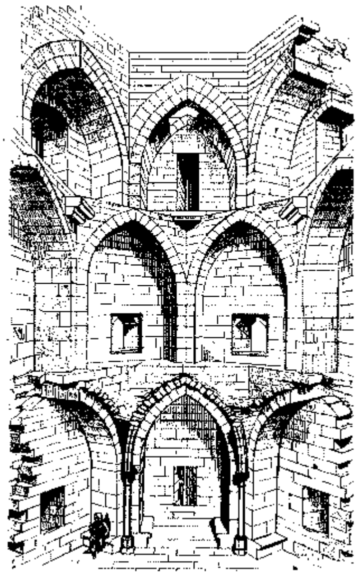


Coucy: donjon, section (from Viollet-le-Duc)



By comparison, the similarly large thirteenth-century donjon at Coucy contained twelve ribs of vaulting that aligned at each level. These created internal buttresses that supported the vaulted ceilings. The smaller outer towers at Coucy, which were also round but only about 18 m in diameter, had staggered casemates.[1009] Although the donjon was large enough to support a significant counterweight trebuchet, the oculus in the centre of the roof, as seen in Viollet-le-Duc's schematics, and vast internal space would have made this impractical. It seems that neither the towers at Coucy nor those at Harran were designed to support extremely heavy artillery.

Coucy: outer tower, interior (from Viollet-le-Duc)



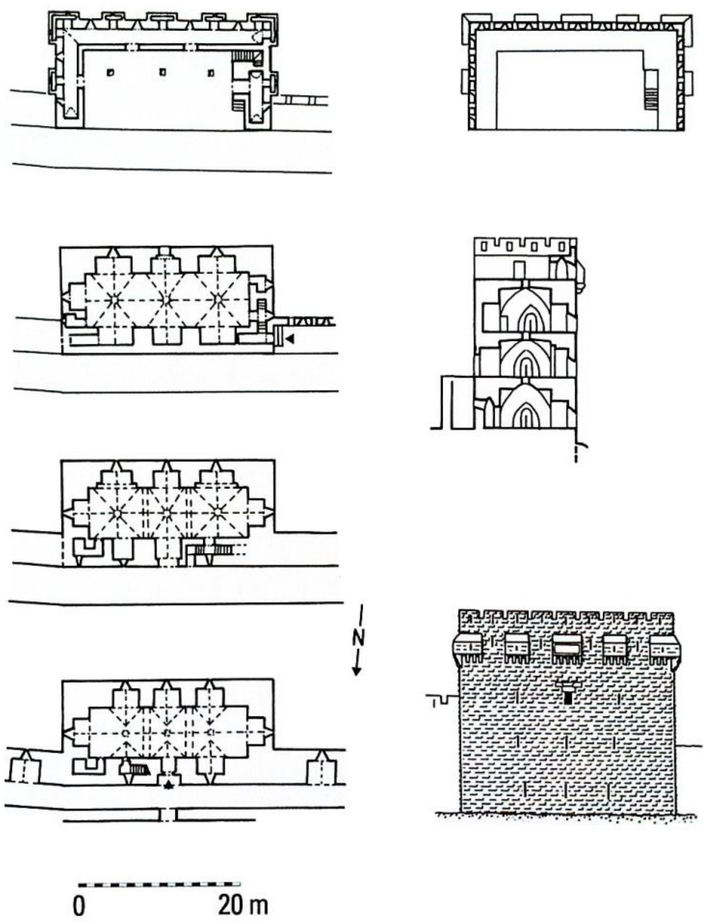
[1009] For a study of Coucy predating the castle's destruction, see Viollet-le-Duc, *Description du Château de Coucy*.

The scale of the towers at Harran appears to have been influenced by a desire to impress onlookers rather than to mount or resist sizable counterweight trebuchets. Heidemann has similarly concluded that the citadel of Raqqa, also built by al-'Adil to a quadrangular plan in the last decade of the twelfth century but with round corner towers, was constructed primarily for symbolic and ceremonial purposes rather than to serve as a seriously defensible strongpoint.[1010] But what of al-'Adil's later preference for quadrangular towers?

Damascus

None of al-'Adil's towers have been scrutinised more than those that he built at Damascus.[1011] A decade after taking power in Damascus, al-'Adil essentially enclosed the earlier Seljuk-Zankid citadel in much the same way as he did certain towers, including Burj al-Haddad, at Cairo. This work might seem justified when considering that the city was besieged no less than five times in the decade immediately following Saladin's death in 1193; however, the defences appear to have been adequate because on only one occasion was the city taken, while the citadel remained a bastion of resistance from which a surrender was negotiated.[1012]

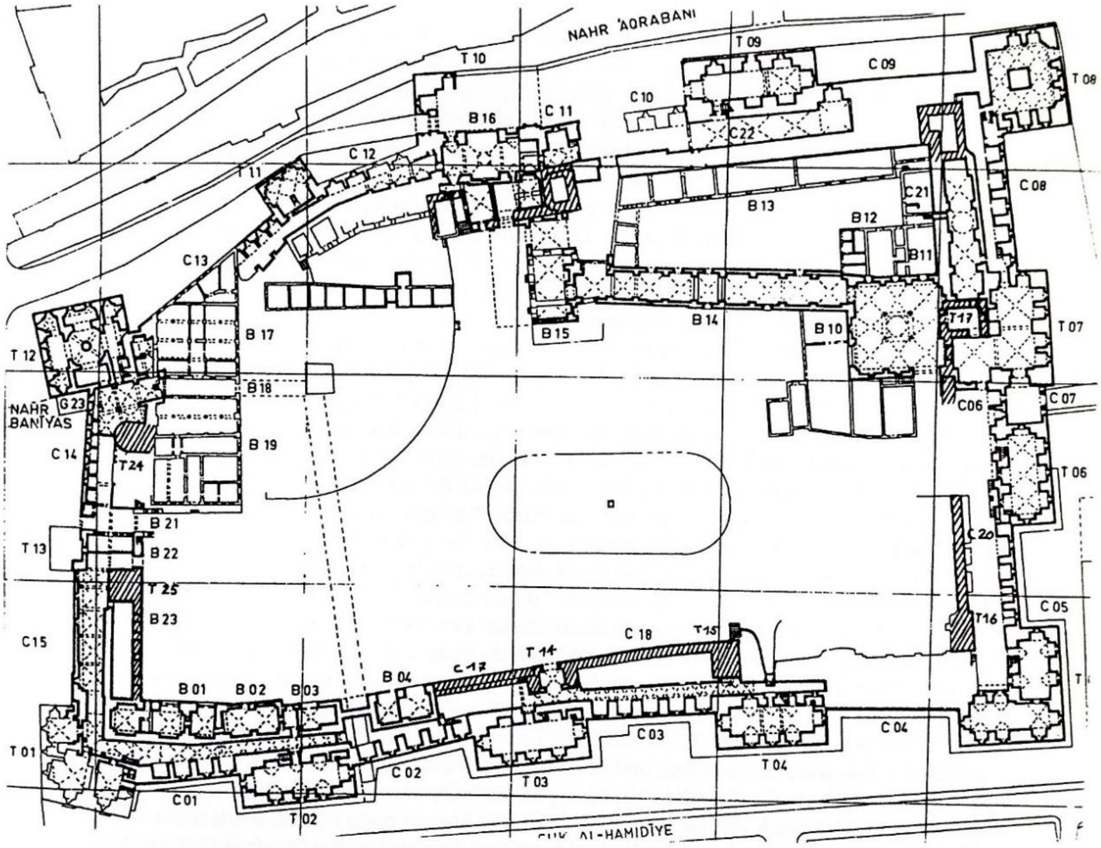
Damascus: citadel tower 3, plan, section and elevation (after Burger and King)



Rather than a response to an acute military threat, the

[1010] Heidemann, "The Citadel of al-Raqqa," pp. 136-145.
[1011] For studies of the citadel of Damascus, see Sauvaget, "La citadelle de Damas," pp. 59-90; Hartmann-Virnich, "Les portes Ayyoubides de la citadelle de Damas," pp. 287-311; Berthier, "La Citadelle de Damas," pp. 151-64; Braune, "Die Stadtbefestigung von Damaskus," pp. 202-10.
[1012] See Chapter 6.

Damascus: citadel, plan (from Berthier)



style, timing, and method with which the citadel was developed suggest that the rebuilding was meant to convey an outward display of power while strengthening the city. Instead of developing the existing defences, al-'Adil had a new enceinte constructed just in front of the existing one, erasing any trace of his predecessors' work when viewed from the outside.[1013] The epigraphic evidence confirms the various sections of the citadel were funded by the Ayyubid princes that he had subjugated and that work was completed between 1207 and 1217, contemporaneous with his work at Cairo.[1014] This, along with the use of much larger towers, was an expression of his power and preeminent position in the Ayyubid world.

Towers 2 and 3, mid-wall towers measuring about 27 m wide and 13 m deep, display little rebuilding since they were constructed under al-'Adil. The Ayyubid battlements, as well as those of other towers that were rebuilt by the Mamluks, consist of two levels and enclose only the three outward faces of each tower. Chevedden has argued

[1013] This is similar to the way in which Saladin surrounded certain parts of Cairo with a new wall that was built ahead of the earlier line.
[1014] Chevedden, *The Citadel of Damascus,* pp. 58-59; Creswell, "Fortification in Islam," p. 123.

that the use of such battlements and the scale of the towers were dictated by the determinant requirements of mounting counterweight artillery.[1015]

While the high battlements could have provided good protection and concealment, and the open backs could have allowed the long arm and sling of a trebuchet to rotate freely, such hypothetical considerations are not sufficient in themselves to prove that the mounting of artillery was a major factor influencing the towers' design.

Citadel of Damascus: Tower and Curtain Dimensions[1016]

	Face Length	*Side Length*	*Thickness*
SW Tower (1)	*missing*		
Curtain (1-2)	*25.0 m*	-	*3.6-4.9 m*
S(w) Tower (2)	26.9 m	12.8 m 8.5 m projection	3.2 m face 3.4 m E side
Curtain (2-3)	*29.0 m*	-	*4.7-4.8 m*
S(c) Tower (3)	26.9 m	12.9 m 8.0 m projection	3.4 m
Curtain (3-4)	*31.5 m (aprox)*	-	*4.5 m*
S(e) Tower (4)	26.4 m	12.9 m 9.5 m projection, E side	3.4 m face
Curtain (4-5)	*31.0 m*	-	
SE Tower (5)	25.0 m S face 27.0 m E face		
Curtain (5-6)	*24.0 m*	-	
E(s) Tower (6)	21.5 m	14.0 m 9.5 m projection, S side	
Curtain (6-7)	*10.0 m*	-	*4.4 m*
Barbican	*10 m (aprox)*	-	*1.87 m*
E(n) Tower (7)	27.5 m	11.5 m projection, S side 7.5 m projection, N side	4.4 m S side 4.7 m N side
Curtain (7-8)	*32.5 m*	-	
NE Tower (8)	24.0 m E face 20.8 m N face	15.0 m projection, S side 8.0 m projection, W side	4.1 m N face 4.4 m S side 3.8 m W side
Curtain (8-9)	*36 m (aprox)*	-	*1.6 m*
N(e) Tower 9	31.0 m	14.0 m 9.0 m projection	4.1m face
Curtain (9-10)	*35.0 m*	-	*4.5 m*
N(c) Tower (10)	29.8 m	17.3 m 14.0 m projection, E side 17.0 m projection, W side	4.1 m N face 4.0 m E side 5.2 m W side
Curtain (10-11)	*24.0 m*	-	*3.6 m*
N(w) Tower (11)	13.5 m	10.7 m	2.4 m face 2.5 m side
Curtain (11-12)	*43.0 m*	-	
NW Tower (12)	20 m		1.8 m E side (Ottoman?)
Curtain (12-1)		-	*5.6 m*

[1015] Chevedden, *The Citadel of Damascus*, pp. 277-78, cf. pp. 192-93.
[1016] From Chevedden, *The Citadel of Damascus*, Appendix 2, pp. 555-58.

First, the Franks had built double-level battlements earlier in the twelfth century at sites such as Jubayl and Saone. This was an excellent way of providing an additional level of firepower at minimal expense and, when coupled with machicolations, was an effective way of covering the base of a tower. Accordingly, the popularity of such battlements grew in the thirteenth century and can be found at sites such as Margat, Crac des Chevaliers and Baalbek. Secondly, there is little to suggest that round towers would have been any less effective platforms for heavy artillery.[1017] The curvature of a rounded tower would provide an even better field of fire, if the engine could be yawed, while this shape would distribute the weight of a large engine more evenly. Thirdly, although the footprints of al-'Adil's towers were considerably larger than previous standards, their construction was rather traditional. The walls are thick, roughly 3.4 m, but not dramatically thicker than many dating to the twelfth century. When considering that the towers contain three internal levels, each with a single open room, and that the strength of the walls was compromised by at least five spacious casemates at each level, the thickness of the walls seems to have been a structural necessity. This is further indicated when considering that the sidewalls of many towers are thicker than the outward faces. Finally, when the northern towers of the citadel were rebuilt by the Mamluks, following the Mongol withdrawal from western Syria, their walls were built to a similar scale. Thus, despite evident improvements in artillery technology by the 1260s, the construction of these towers does not appear to have been significantly influenced by considerations of artillery.

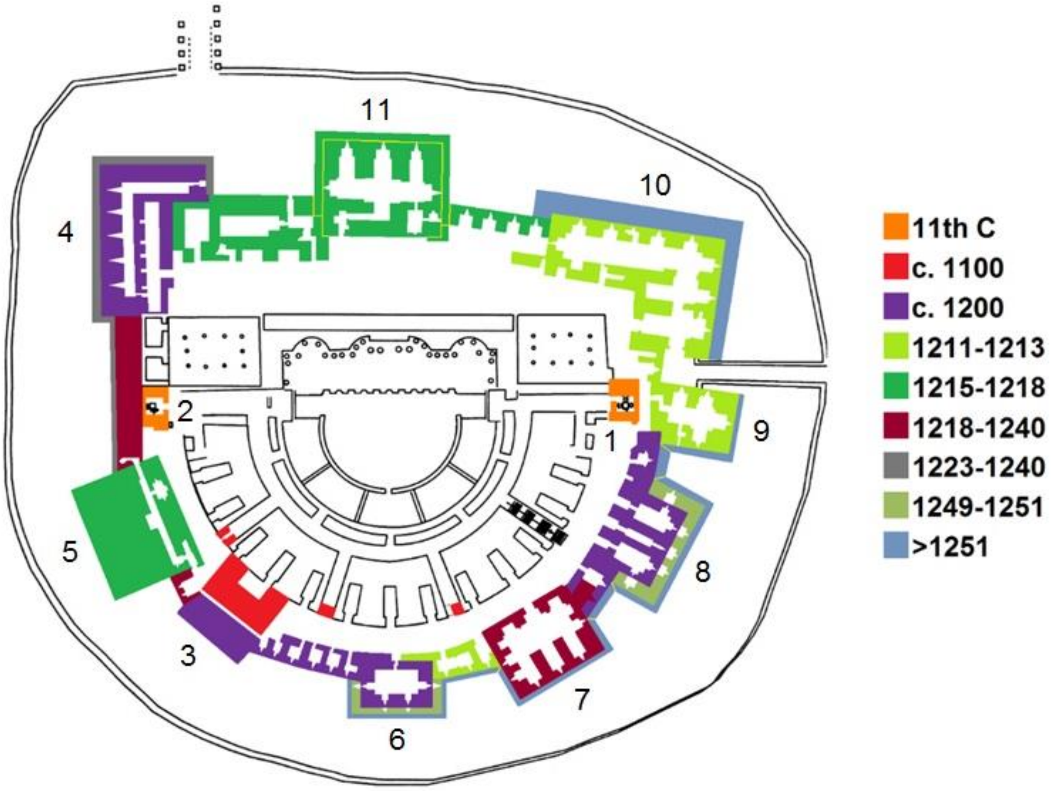
By the time construction started at Damascus, al-'Adil appears to have settled on a preference for quadrangular towers: typified by the same general plan, scale, rusticated masonry and use of box machicolations. Massive towers of this design were built at Cairo and Damascus and slightly smaller ones at Mount Tabor and Bosra. While those at Mount Tabor have been largely destroyed, those at Bosra remain in a relatively good state of preservation.

Bosra and 'Ajlun

Trajan's theatre at Bosra, like that at Caesarea, had been used as a fortress since at least the late eleventh century. The towers built here by al-'Adil are all smaller than those that he built at Damascus; however, they were built over a longer period of time and appear

[1017] Cf. France, *Western Warfare*, p. 124.

Bosra: citadel, plan (after Yovitchitch and Bavrou)



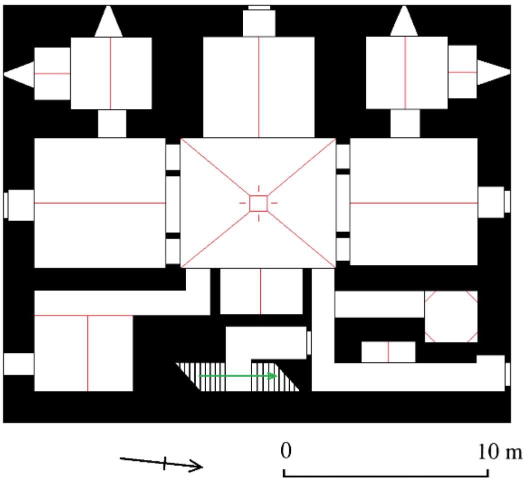
to reveal the development of his stylistic preferences. Towers 4, 6 and 8 are relatively simple and only corner tower 4 was built with walls of any great thickness. Tower 10 is quite similar to contemporary tower 5 at Damascus, while mid-wall towers 11 and 5 resemble compressed versions of towers 2, 3 and 4, built less than a decade earlier at Damascus.[1018] Although the mid-wall towers are only about a third of the size of those at Damascus, it is hard not to be struck by the high vaulting and vastness of the open space within them.

Citadel of Bosra: Epigraphic Dating[1019]

	Date	*Attribution*
Tower 1	481 [1089]	*Abu Manur Kumushtekin*
Tower 3	542 [1147-48]	*Mu 'In al-Din Anur*
Tower 4	599 [1202-3]	*al-'Adil*
Tower 10	608 [1211]	*al-'Adil*
Tower 9	609-10 [1212-13]	*al-'Adil*
Tower 11	612 [1215]	*al-'Adil*
Tower 5	615 [1218]	*al-'Adil*
Tower 4 (glacis)	638 [1240-41]	*al Salih Isma'il*
Tower 6	647 [1249]	*al-Salih Ayyub*
Tower 8	659 [1250-51]	*al Nasir Yusuf*

[1018] For the dating of the towers at Bosra, see Yovitchitch, "La citadelle de Bosra," pp. 205-17; Yovitchitch, "Bosra: Eine Zitadelle," pp. 167-77.
[1019] From Yovitchitch, "La citadelle de Bosra," p. 216.

Bosra: citadel tower 5 (after Yovitchitch)



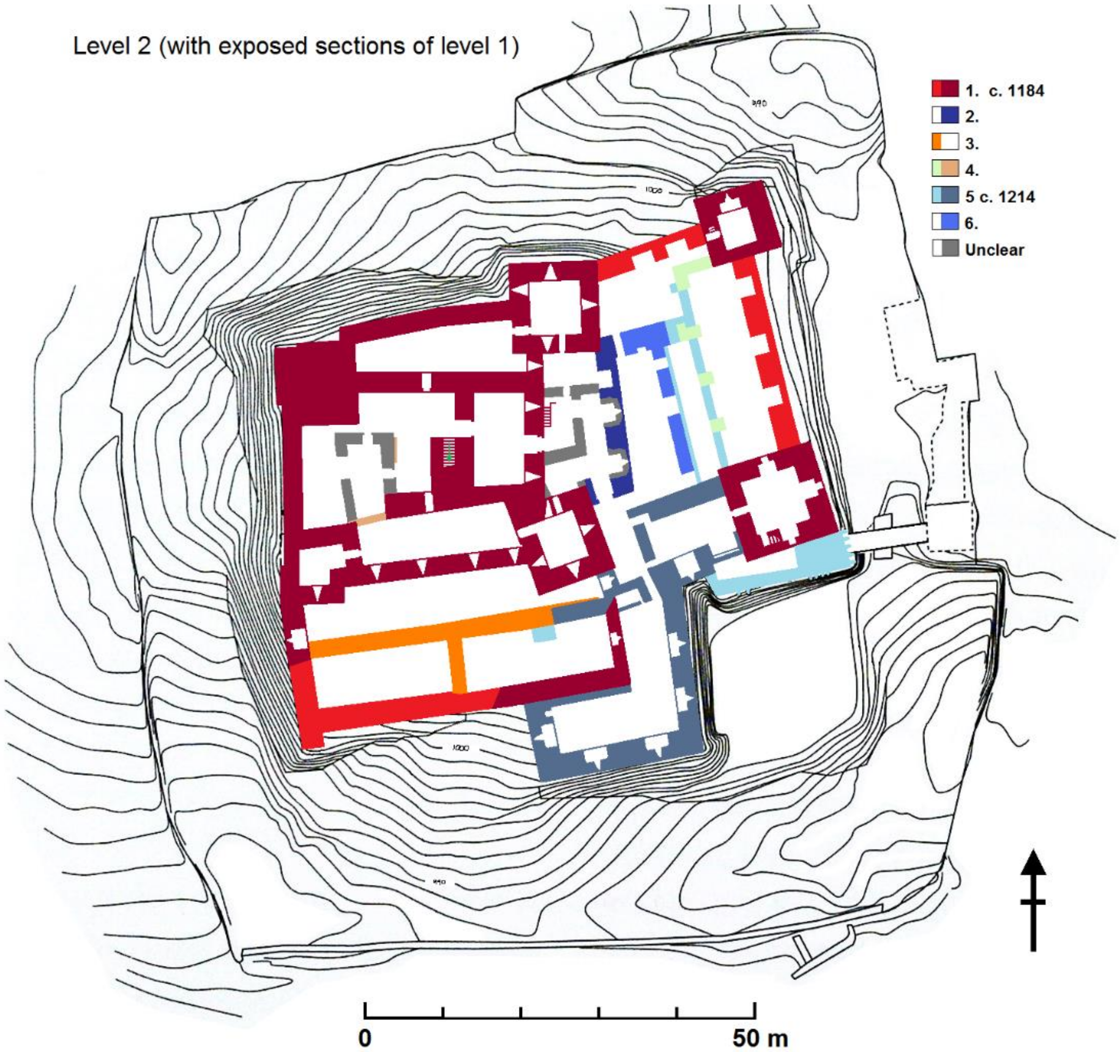
Once more a desire for opulent display appears to have influenced the design of these towers. The towers become more structurally open with time, so that tower 7 is even more spacious inside that those built by al-'Adil. Rather than being built stronger to counter the increasing power of artillery, structural strength was progressively sacrificed for interior space throughout the first third of the thirteenth century. It might be argued that the later encasing of towers 6 and 8 reflects a need for stronger towers; however, this may have been done, at least in part, to give the citadel a more uniform appearance from without, as very similar masonry was used to that employed earlier.

The castle of 'Ajlun was founded by Izz al-Din Usama in 1184-85. It was besieged by an Ayyubid army in 1211-12 and then developed by Izz al-Din Aybak. When comparing the work completed under Saladin with that carried out under al-'Adil, the exterior walls are all 2-3 m thick and there are few differences in respective masonry techniques apart from the embrasures and other stylistic signatures. Without its uppermost level it is impossible to rule out the possibility that the thirteenth-century corner tower was designed to be a platform to support heavy artillery; however, considering the layout of the lower levels, there is little to suggest that this was the case.[1020] Instead, it may have been built to resemble outwardly those

'Ajlun: Aybak's Tower, from the southeast (author)

[1020] For archaeological investigations of 'Ajlun, see Johns, "Medieval 'Ajlun," pp. 21-33; Yovitchitch, "Die Aiyubidische Burg 'Aglun," pp. 118-25; Yovitchitch, "The Tower of Aybak," pp. 225-42.

'Ajlun: castle, plan (after Yovitchitch and Johns)



built by al-'Adil, though internally it is very different given the existing structure around which it was built.

Continuity

The scale of al-Zahir Ghazi's large gatehouse at Aleppo also appears to have been inspired by a desire to impress, rather than to support heavy artillery. It is perhaps not surprising that these large towers were built by dynastic rivals, intending their architecture to reflect their relative prowess.[1021] Chevedden's suggestion that new artillery towers were also built at Beaufort, Shayzar, Baalbek and Subayba is confusing:[1022] the northern tower built by the Ayyubids at Beaufort is similar in scale to the earlier keep built by the Franks; the

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[1021] See also Michaudel, "Development of Islamic Military Architecture," pp. 112-16; Yovitchitch, *Forteresses du Proche-Orient*, pp. 177-210. Although built independently, Aybak may have intended his tower to resemble those of his superior, al-'Adil, as a symbol of his support.
[1022] Chevedden, *The Citadel of Damascus*, pp. 286-88.

southern donjon at Shayzar seems to have been a relatively palatial structure;[1023] and the only towers of notable scale at Baalbek and Subayba were built by the Mamluks. Besides the massive towers built by al-'Adil and al-Zahir Ghazi, more traditional building trends continued in the thirteenth century.

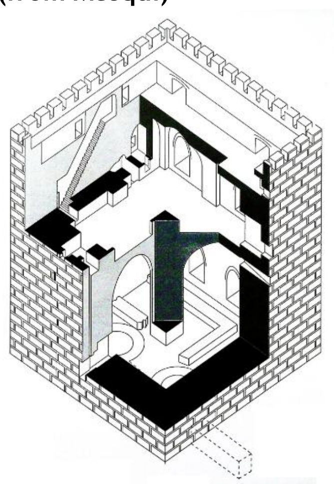
Much smaller Ayyubid towers, can be found at sites such as 'Ajlun, Subayba, Baalbek, Apamea, Palmyra, Harim and al-Rahba. Chevedden's arguments concerning the need to mount heavy artillery have permeated into studies of even such small towers.[1024] Most suggestions that counterweight trebuchets were, or were not, erected on top of certain towers not only lack an accompanying assessment of the utility of elevating such engines in this way, but also neglect any consideration of the forces that such towers would need to withstand. Ironically, some of the most appropriate towers to have carried such loads predate the battle of Hattin.

Possible Frankish Artillery Towers

Twelfth-century Keeps

Probably dating to the middle of the twelfth century, the 24.5 m square tower in the centre of the eastern wall at Saone boasts walls 4.4-5.4 m thick.[1025] A solid central pier runs through both internal levels, supporting four bays of groin vaults in each. This combination of strengths make it possibly the most suitable pre-Mamluk tower on which a counterweight trebuchet could have been mounted in or around the Latin East. However, from the accounts of the 1188 siege of the castle, it seems no such heavy weaponry was positioned here. The effectiveness that such an engine would have from here is questionable: the girth of the castle's eastern defences protected it from any incoming artillery fire while small-arms and light artillery would have been the

Saone: donjon, cutaway (from Mesqui)



[1023] See Tonghini and Montevecchi, "The Castle of Shayzar: The Results," p. 145.

[1024] This is clear in Bylinski's analysis of al-Rahba, Chevedden's arguments having been considered via Kennedy, Bylinski, "Three Minor Fortresses," pp. 157-58, cf. n. 9.

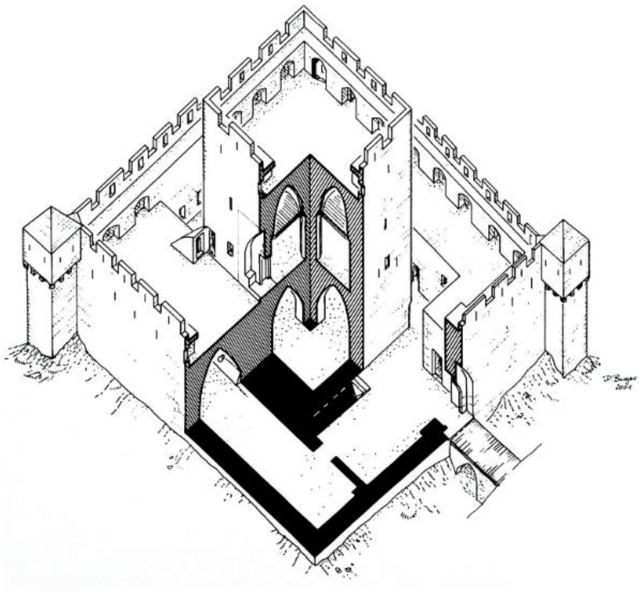
[1025] Deschamps, *Les Châteaux,* 3:235-36, 239-40; Mesqui, "Saône," pp. 12-13.

most effective defensive weapons against any forces massing on the ridge opposite the abyss of the eastern fosse.[1026]

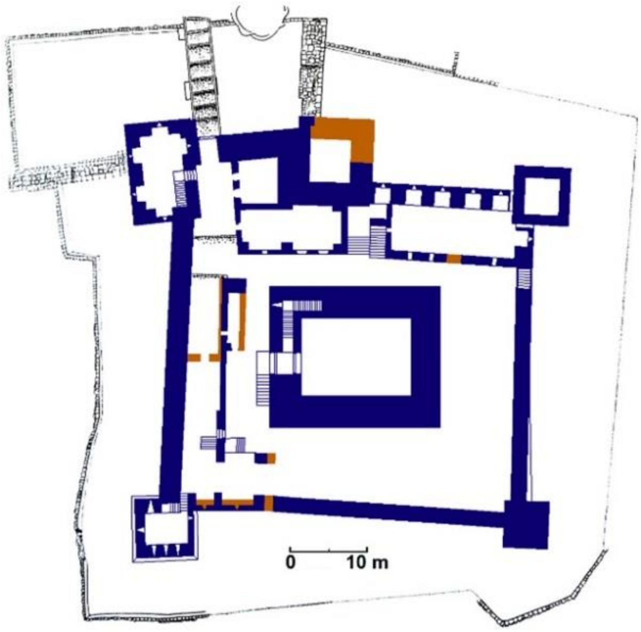
Similar to the donjon at Saone, the central keep of the twelfth-century Hospitaller castle of Chastel Rouge, measuring approximately 14 m by 16 m, is also built around a strong central pier. This tower has walls over 2 m thick and two internal masonry levels, while the upper is divided by a wooden floor to create a third.[1027]

Although the central keep of Jubayl, 22 m by 18 m, has no central pier rising through its two levels, its 4 m thick walls occupy almost two thirds of the structure's total footprint.[1028] Saladin's apparent inability to destroy the keep in 1190 speaks to its strength.[1029] Although all three appear to have had two levels of battlements running around them, artillery seems to have been used to defend none of them in 1188.[1030]

Chastel Rouge: castle, cutaway (from Biller)

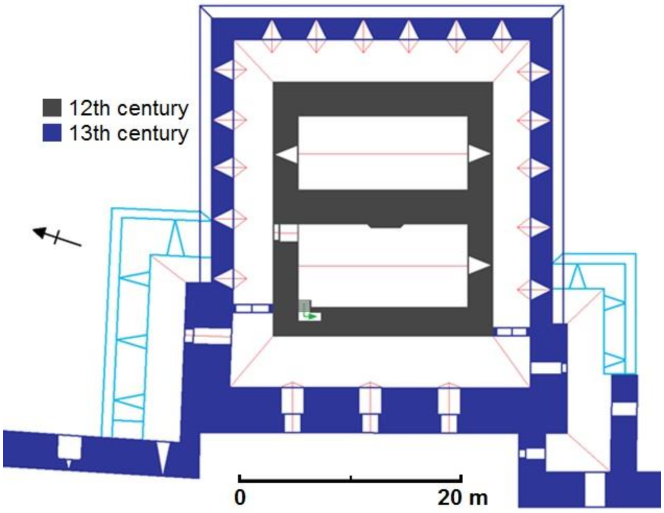


Jubayl: castle, plan (after Deschamps)



[1026] For Saladin's siege of Saone in 1188, see Chapter 5.
[1027] For Chastel Rouge, see Mesqui, "Qal'at Yahmur," pp. 5-6; Kennedy, *Crusader Castles*, pp. 74-75; Pringle, *Red Tower*, pp. 15-17; Müller-Wiener, *Castles of the Crusaders*, p. 52; Deschamps, *Les Châteaux*, 3:317-19.
[1028] Deschamps, *Les Châteaux*, 3:210-11; Rey, *Étude sur les monuments*, pp. 117-20; Kennedy, *Crusader Castles*, pp. 65-66; Müller-Wiener, *Castles of the Crusaders*, p. 64.
[1029] Wilbrand of Oldenbourg, *Itinerarium terrae sanctae* 1.6, ed. Pringle, p. 119, trans. Pringle, p. 167. Cf. 'Imad al-Din, *al-Fath*, trans. Massé, p. 231.
[1030] For Saladin's acquisition of Chastel Rouge, see 'Imad al-Din, trans. Massé, p. 122; Abu Shama, *Kitab al-Raudatain*, RHC Or 4, p. 352. Cf. Ibn al-Athir, *al-Kamil*, trans. Richards, 2:344; Baha' al-Din, *al-Nawadir*, trans. Richards, p. 81. For Jubayl, see Chapter 5.

Tortosa: donjon, plan (after Pospieszny and Braune)



Another candidate is the Templar keep at Tortosa. The tower is 20 m square with walls 3.5-5m thick, vaulted internally by parallel barrel vaults supported on a cross-wall. It seems the keep, which formed the nucleus of the thirteenth-century castle, was the same tower that was successfully defended by the Templars against Saladin's assault in 1188.[1031] No defensive artillery is mentioned in the accounts of this siege.[1032]

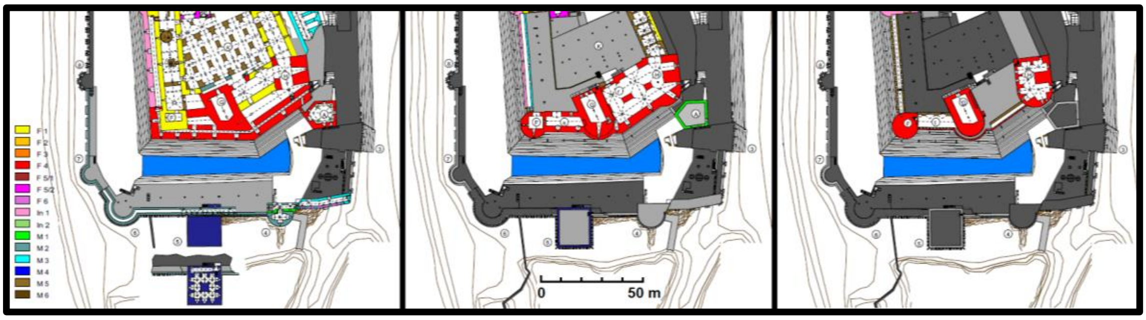
The large twelfth-century Frankish tower at Toron, commonly identified as the keep, was similarly planned with a cross-wall dividing its long axis but no artillery is mentioned in its defence in 1187.[1033] Despite their potential ability to support quite significant loads, the lack of any source evidence to suggest that these towers were used as artillery platforms in the late twelfth century has allowed them to be completely overlooked in favour of others built in the early thirteenth.

<u>Crac des Chevaliers</u>

The three southern towers of Crac's inner enceinte, like most of the castle's impressive elements, postdate the earthquake of 1202 and appear to be the only Frankish towers where heavy artillery could have been positioned.[1034] The circular westernmost tower is the smallest. Although more than 10 m in diameter, the encircling parapet would probably have imposed serious restrictions on the sling of even a small counterweight engine. Space would not have been an issue on top of the central and eastern towers because of their rearward extension. Structurally, the walls of the central tower are continuous from

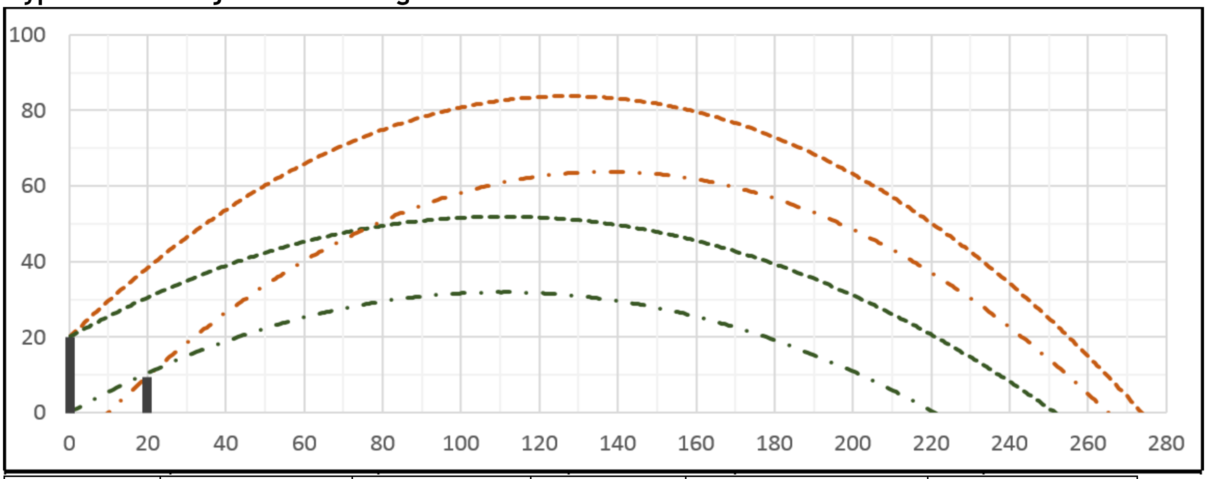
[1031] Given the similarities of the keep, following the addition of the talus, to Frederick II's keep at Lucera, built c. 1235 after the emperor returned from the Holy Land, Pospieszny has suggested that the former influenced the latter, dating the additions to the original structure no later than the 1220s, Pospieszny, "Tortosa (Syrien) und Lucera (Apulien)," pp. 243-46.
[1032] For Saladin's siege of Tortosa in 1188, see Chapter 5.
[1033] For the keep at Toron, see Piana, "The Crusader Castles of Toron," pp. 181-83. For the siege of Toron in 1187, see Chapter 5.
[1034] For recent studies of these defences, see Häffner, "Die Südtürme der Kernburg im 13. Jahrhundert," pp. 142-84; Mesqui, "Les programmes architecturaux," pp. 3-7.

Crac des Chevaliers: southern defences, plan (after Mesqui and Anus)



their foundations to the parapet, supporting a single barrel vault along the tower's long axis at each level. The eastern tower is more complex as openings were left in its supporting walls to facilitate movement through the castle at the first and second (ground- and first-floor) levels. Despite this apparent weakness, the tower's northern corners and south face were maintained as structural piers as was a portion of the western wall. The tower's eastern wall thins as it rises but a pier, almost 6 m wide, sustains the full 8 m thickness of the wall at its base, dividing a pair of east-facing embrasures at each of the three internal levels. Accordingly, anything sitting on the eastern side of this tower's roof rests on a solid pier of masonry reaching down to the bedrock, similar in concept to the rear half of the much older mural towers of Antioch. Accordingly, it seems possible, albeit far from certain, that the eastern tower, and possibly even the central tower, may have been able to support the weight and stresses of mounting a counterweight trebuchet.

Hypothetical Trajectories of Engines at Crac des Chevaliers



Position	Horiz. Pos.	Vert. Pos.	Velocity	Release Angle	Max. Range
Tower	0 m	20 m	50 m/s	45°	273.7 m
Tower	0 m	20 m	50 m/s	30°	251.4 m
Ground	10 m	0 m	50 m/s	45°	265.1 m
Ground	0 m	0 m	50 m/s	30°	220.9 m

Crac des Chevaliers: outer southern wall, from the west (Denys Pringle)

The height of these towers and the relatively confined spaces on top would have made it very difficult to move an engine's components and ammunition up to such positions and then back down to be stored under cover.[1035] When considering that the construction of the outer wall would have removed most of the relative range advantage,[1036] these difficulties could be avoided by erecting any heavy engines in the open space to the west of the *berquilla*, leaving the lofty and commanding towers free for other forces. The construction of the outer wall also provided an alternative position for lighter artillery, one which has thus far been overlooked by scholars.

Along the inside of the outer southern wall there is a structure, 68 m long, commonly identified as the Frankish stables.[1037] The terrace roof of this structure effectively widens the fighting platform an additional 10 m and would have afforded an ideal position to mount defensive artillery. The battlements, especially if they were of two levels as they were during the Mamluk period, would have provided excellent cover while

[1035] The impact of weathering on exposed wood would have made storing the engines under cover necessary, at the very least during the winter months, similar to the storage of sixteenth- through eighteenth-century wooden gun carriages.
[1036] Although lower, these engines would have been farther forward, between the inner and outer walls, yielding comparable ranges.
[1037] For this structure, see Biller, et al., *Der Crac*, pp. 249-51.

the open space on three sides left nothing to obstructing the firing process of a trebuchet and allowed personnel to move freely around such engines. However, the vast breadth of the vaulting below suggests that this would have been an ideal position for traction- rather than counterweight-powered machines.

Crac des Chevaliers: outer southern wall, from the east (Denys Pringle)

Although the vaulting of the Frankish stables was not strengthened after 1271, Jean Mesqui has dated the masonry that now blocks the eastern door and the staircase that provides access to the roof from the east to after the Mamluk siege.[1038] This suggests that the value of this fighting platform was readily appreciated but that heavy artillery was at no point placed here. While it is possible that counterweight artillery might have been erected on one or two of Crac's Frankish towers, two other towers frequently supposed to have been designed to carry heavy artillery are found at 'Atlit.[1039]

Crac des Chevaliers: interior of the Frankish stables, looking west (Denys Pringle)

'Atlit

The thick side walls of 'Atlit's outer eastern towers appear to have allowed them to bear considerable loads. Although the towers have not survived to their original height, in his analysis, C. N. Johns speculated that the internal vaulting of the second level (first floor) would have projected up through the roof level, thus denying the opportunity to employ any kind of artillery on top of these towers.

[1038] Mesqui, "La troisième enceinte," p. 13.
[1039] Both the southern inner towers at Crac and two inner towers at 'Atlit were noted in Chevedden's original study, Chevedden, *The Citadel of Damascus*, pp. 289-90.

Behind the outer line of defences soared two colossal towers, the northern of which still survives to a height of 35 m, almost its original height. The towers were 27 m wide with walls approximately 5 m thick and contained three levels, the highest of which made up nearly half the height of each tower.[1040] The towers were built using immense blocks, each weighing more than a ton, cut with 4 cm margins no less than 7 cm deep, leaving bosses that extended out up to 30 cm.[1041] Although cut from the same soft stone found elsewhere along the Palestinian coast, the extremely hard Frankish mortar and rubble fill gave these walls considerable strength.

It is the outstanding height of these towers that tends to nominate them as pseudo equivalents to al-'Adil's supposed artillery towers.[1042] Despite the unprecedented thickness of their walls, it seems unlikely that they ever supported heavy counterweight trebuchets. There may have been a central pier rising through the middle of the second and third levels, creating bays of groin vaults, but this does not appear to have been present at the lowest level. While the towers would have provided an impressive vantage point and could very well have supported traction artillery, the vast volume of internal space, especially at the third level, appears to have rendered them unfit to withstand the stresses created by the sudden drop and subsequent swinging of a sizable counterweight. To this can be added the difficulties of moving such an engine into position.

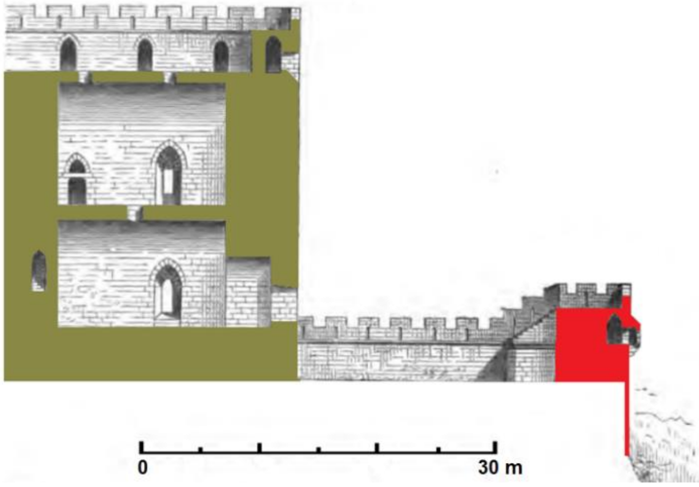
The height of these towers would have given any artillery placed on them an advantage in range compared to any situated on the ground just behind the outer curtain; however, the latter position provided greater protection and left the tower-tops free for archers and slingers, who required line-of-sight. Accordingly, the *trabuculum* that defended the castle in 1220 was probably positioned on the ground, behind the outermost curtain, regardless of whether the towers had been completed by this date.[1043] It is possible that the two towers may have been better suited to support such an engine before the uppermost level was added, but the open space at the first level discourages such a suggestion.

[1040] Johns, *Guide to 'Atlit*, pp. 36-37, 44; Johns, "Excavations at Pilgrims' Castle, (1932)," pp. 152-53; Boas, *Crusader Archaeology*, pp. 111-12; Conder and Kitchener, *Survey of Western Palestine*, 1:195.
[1041] Conder and Kitchener, *Survey of Western Palestine*, 1:296. In disagreement with *The Survey of Western Palestine*, T. S. R. Boase has suggested that these blocks may have been reused from an earlier Phoenician settlement, Boase, "Military Architecture," pp. 157-58.
[1042] For example, Nicolle, *Crusader Castles*, p. 67.
[1043] If the outer line was incomplete at this point in history, the outer curtain in 1220 would have been what is now the inner curtain between the two tall towers.

Margat

At Margat, some have suggested that artillery could have been placed on the terrace along the eastern face of the citadel,[1044] while others have looked to the roof tops of towers. Through his work at the castle, Balázs Major has identified the light structure of certain upper-level buildings, which would not be suitable for heavy artillery, but has suggested that the roof of the chapel might have supported an engine.[1045] The chapel, however, faces the steep drop beyond the eastern wall of the citadel and is well withdrawn from the exposed southern salient, making the donjon further south a more suitable position.

Margat: southern defences, section (after Rey)



There would have been plenty of space on top of the donjon, which is just over 20 m in diameter.[1046] But despite its thick walls, the open space of the internal levels, each laid out as a single-room under a barrel vault, would have restricted the amount of vertical load and lateral strain that this tower could have supported. As at other castles, there is ample space elsewhere to erect such engines, sacrificing minimal range while gaining protection.

At most, Margat's donjon, similar to the keep at Jubayl, may have supported lighter artillery behind its double-level battlements. Round towers of a similar scale in Europe, such as those at Coucy, Pembroke and Aigues Mortes, likewise do not appear to have been designed to support heavy artillery on their roofs.

Arsuf

Jean Mesqui has suggested that the outer walls at Arsuf may have been designed in part to accommodate heavy artillery.[1047] Both the north and south protrusions, however, mirror the inner towers, leaving only the eastern lobe, directly in front of the inner gate, with

[1044] For this example see, France, *Western Warfare*, p. 105; Nicolle, *Crusader Castles*, p. 79.
[1045] Major, "Medieval 'light construction buildings'," pp. 165-81; Major, "Medieval Cranes," pp. 1-5.
[1046] Rey, *Étude sur les monuments*, p. 30; Deschamps, *Les Châteaux*, 3:272; Kennedy, *Crusader Castles*, pp. 173-75.
[1047] Mesqui, "La fortification des Croisés," p. 8.

enough room to host an engine of any notable size. Erecting a large engine here, however, would restrict mobility around the castle, a cost with debatable benefit. The burnt cedar logs and concentration of sizable projectiles found between the north and east lobes, may indicate that the defenders were employing smaller engines from more restricted positions.[1048]

It is difficult to gauge accurately the size of the engines typically employed defensively by the Franks. It would appear that more thought was given to defensive artillery than simply using stockpiled engines otherwise intended for offence. Ibn al-Furat seems to suggest this when mentioning the defensive engines at Jaffa in 1266.[1049] Most defensive engines would have been lighter traction trebuchets; however, heavier engines appear to have been employed defensively at Acre (1190-91), 'Atlit (1220), Margat (1285), and almost certainly during the Mamluk siege of Acre in 1291. Considerations for the employment of such engines do not appear to have influenced significantly the planning of fortifications during most of the thirteenth century. There are indications, however, that the Mamluks may have attempted to mount counterweight trebuchets on certain towers by the end of the century.

Possible Mamluk Artillery Towers

From Ibn al-Furat's account we may deduce that wall-mounted artillery was a critical component of Baybars' arrangements to improve the defensibility of Alexandria in 1272-73. In a subsequent letter, the city's governor reported that around one hundred machines had been prepared.[1050] Bearing in mind that Baybars was certainly storing heavy artillery in his strongholds by this point, it remains to be considered whether a desire to mount the heaviest engines on towers motivated any of his rebuilding efforts, or those of his immediate successors.

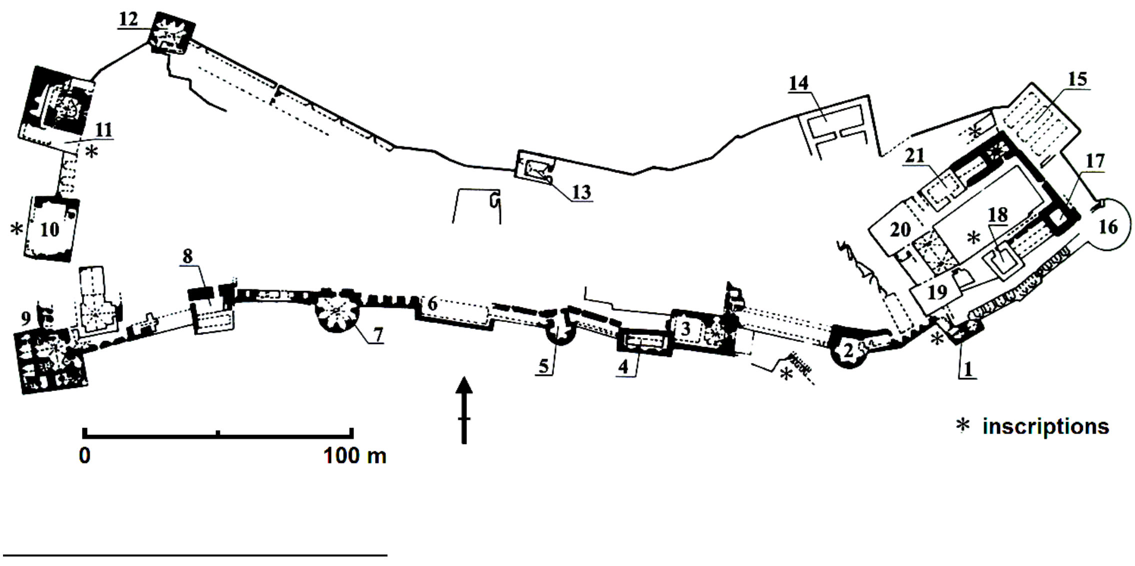
[1048] See Raphael and Tepper, "The Archaeological Evidence," p. 87.
[1049] Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:90-91. Cf. **Fig. B23**.
[1050] Ibn 'Abd al-Zahir, *al-Rawd*, trans. al-Khowayter, 2:795-96; Ibn al-Furat, *Tarikh*, trans. Lyons and Lyons, 2:159.

Subayba

The Mamluks developed the Ayyubid outer defences of Subayba, which had been slighting by the withdrawing Mongols.[1051] France has casually suggested that the round towers built along the southern curtain (towers 2, 5, 7 and 16) may have mounted heavy engines.[1052] The size of tower 7 and its vaulting, a 4 m wide barrel vault radiating around a central pier, indicate that it may have been able to support significant loads. Tower 16 is of a similar size but lacks the support of a central pier. The castle's largest towers, however, are quadrangular.

In the centre of the western wall, tower 10 seems not to have been developed by the Mamluks and retains its relatively thin Ayyubid walls and open interior space. Tower 15 may have been laid out in a similar fashion to the southern donjon at Shayzar, although its internal plan is now hard to confirm. Towers 11 and 9 were essentially encased. Tower 11, originally built by al-Aziz Uthman in 1230, had substantial walls, 2.5-3.7 m thick, but was much smaller than those built by al-'Adil.[1053] It was enlarged in 1275 using massive blocks, averaging 7 tons. Hartal has suggested that the scale of these building stones was necessary to retain the fill behind the walls, as the western wall was advanced down the slope, and support the two levels above, which reached an estimated height of 30 m.[1054] Although the Ayyubid tower and surrounding structure provided quite a strong base, the

Subayba: castle, plan (after Hartal and Deschamps)

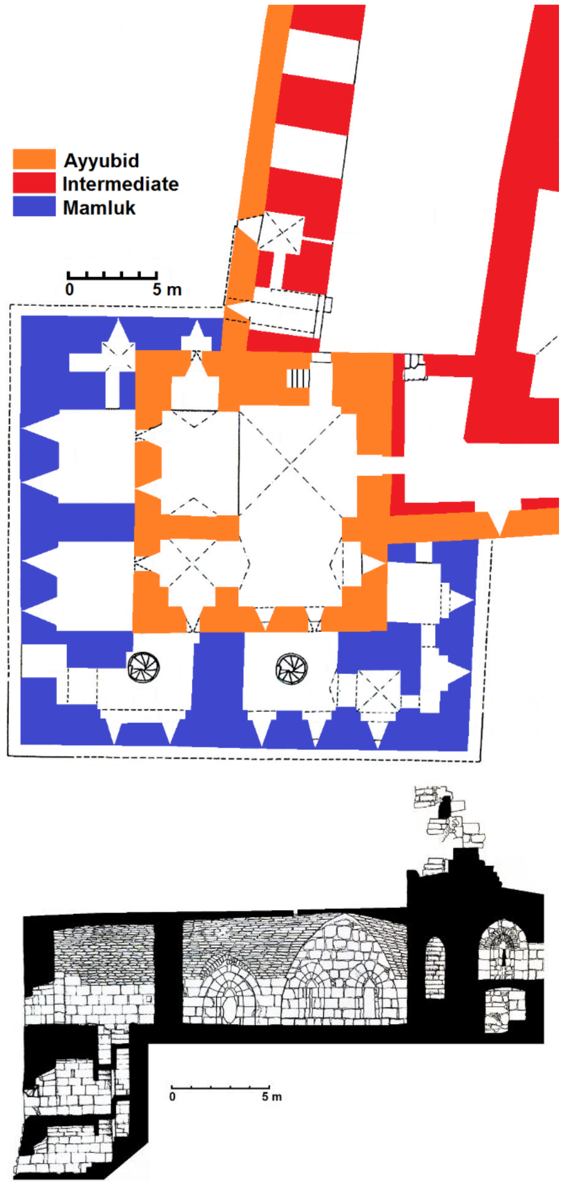


[1051] The castle was built by al-Aziz Uthman c. 1228. Despite misdating the construction of the castle to the Franks in the twelfth century, Deschamps' study continues to form the basis of subsequent studies, Deschamps, *Les Châteaux*, 2:145-74; Müller-Wiener, *Castles of the Crusaders*, pp. 45-46; Benvenisti, *The Crusaders*, pp. 147-74; Ellenblum, "Who Built Qal'at al-Subayba?" pp. 103-12; Hartal, *al-Subayba*.
[1052] France, *Western Warfare*, p. 124.
[1053] Hartal, *al-Subayba*, pp. 3, 9, 12-14, 17.
[1054] Hartal, *al-Subayba*, pp. 20, 36.

third level of the Mamluk tower appears to have been a single open room, limiting the vertical load that the vaulting could carry. In Hartal's opinion, the creation of this opulent hall was the impetus for the tower's expansion.[1055]

The Ayyubid walls of tower 9 were much thinner, about 1.4 m thick. Even at its earliest phase this tower appears to have been designed to incorporate numerous embrasures, allowing it to control movement around this salient of the castle. The present Mamluk tower has only slightly thicker walls but its construction increased the number of embrasures at the first level from eight to fourteen. The construction of two sub-levels, necessitated by the slope of the ground, led to the creation of a further five southward, one westward and two eastward-facing casemates at the first of these and another four to the south at the lower level.[1056] Intriguingly, the Mamluk extension created firing chambers, leaving large piers of masonry to break up what could otherwise have been a continuous gallery. These divisions increased the vertical load that each level could support, but their primary purpose appears to have been to add cohesive strength, perhaps against mining. Above the first level, traces of both the Ayyubid and Mamluk structure are clear in the northwest corner of the tower, revealing no less than another four Mamluk embrasures in what little remains. Traces of an Ayyubid staircase are still discernible, to service a third level, now completely obscured.

Subayba: tower 9, plan and section (after Hartal)



[1055] Hartal, *al-Subayba*, pp. 41, 72. The picturesque views from this position and fine internal masonry further suggest that concerns of comfort outweighed those of defence at this upper level.

[1056] Hartal, *al-Subayba*, pp. 75-79, 68-90. The spiral staircases providing access to these sub-levels are extremely rare examples of this form of staircase built in this region during the period of the crusades.

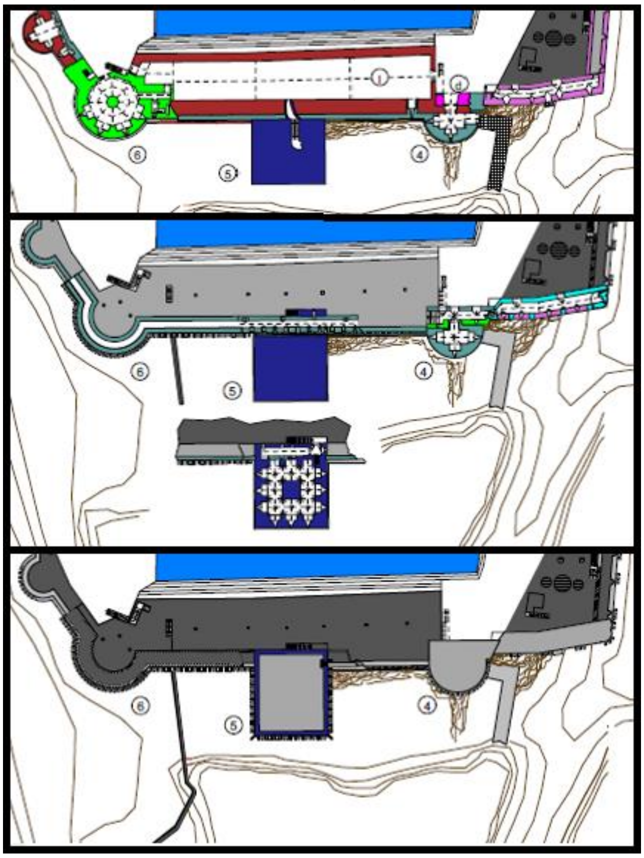
While the layout of what has survived of this tower suggests that it may have been able to bear a substantial and perhaps even dynamically shifting load, the structure of the upper levels is unclear, as are the motivations for building a tower to accommodate heavy artillery at a salient that is naturally difficult to approach. Instead, the tower appears to have been designed for small-arms fire, like the outer towers at 'Atlit and tower E at Montreal.

Crac des Chevaliers

The most obvious example of a tower capable of carrying immense loads is the massive quadrangular tower, about 20 m square, completed by Qalawun at Crac des Chevaliers around 1285.[1057] The tower contains a single internal level at the same height as the upper parapet of the adjacent curtain walls. This level is essentially a gallery: eight bays of groin vaults arranged around a central square pillar, slightly larger than the bays themselves. The seven exterior bays provide access to casemate, each extending halfway through the external wall to service an embrasure, while the internal three bays provide access to the tower. The tower is solid below this level with the exception of a narrow passage connecting the Frankish stables with a postern in the east face of the tower. The roof was surrounded by an open-backed double-level parapet, similar to that found at Damascus.

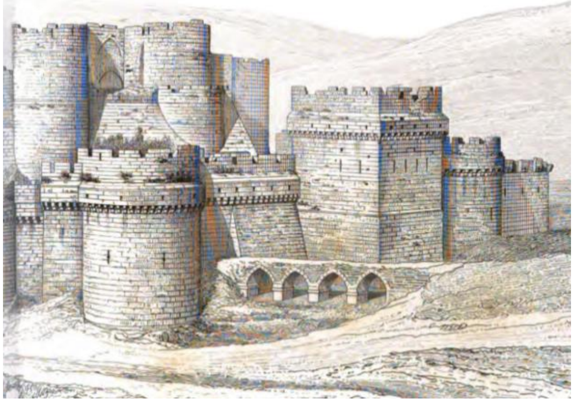
The solidity of this tower and large central pier through its single internal level, would have made this tower capable of supporting immense loads and dynamic forces. While it cannot be ruled out that the tower's design was inspired to confound the work of sappers, this would have been an ideal position to

Crac des Chevaliers: outer southern defences, plan (after Mesqui and Anus)

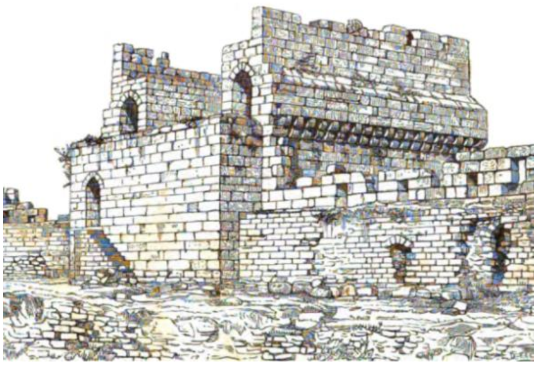


[1057] Deschamps, *Les Châteaux*, 1:157 n. 2; Biller, et al., *Der Crac*, pp. 251-52.

Crac des Chevaliers: outer southern defences, from the southwest (from Rey)



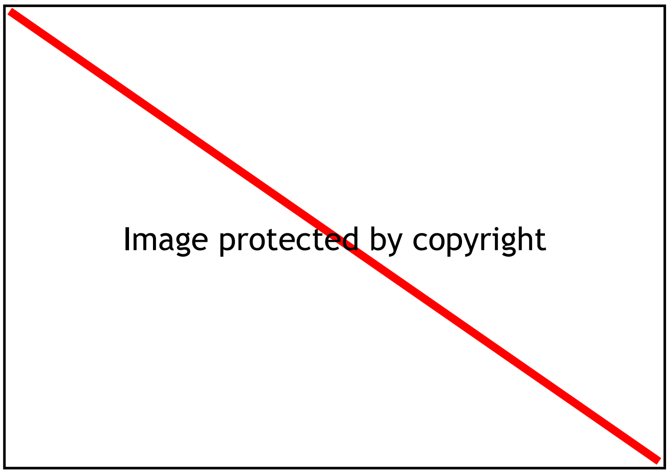
Crac des Chevaliers: rear of the southern quadrangular tower (from Rey)



mount a counterweight trebuchet. The tower provided both space and protection while there was ample room along the broad fighting platform to either side for lighter artillery and small-arms fire. But despite these favourable conditions, there is no direct evidence to prove that this tower ever carried any kind of thirteenth-century artillery.

Just to the west of this quadrangular tower is a slightly earlier rounded Mamluk tower, rebuilt over the remains of a Frankish tower after 1271.[1058] This tower has a similar layout to tower 7 at Subayba. It contains a single internal level, arranged in an octagon around a central pier of the same shape and a diameter half the span of the encircling vaulting. Casemates were provided in each of the tower's four external faces. This tower would have been able to support considerable loads, unlike the tower just to the northwest, which is also rounded but was given an almost flat ceiling vault at the second level.[1059] It is possible that the design of this tower, with its single internal level and central pier, inspired that of the more dramatic quadrangular one built next to it.

Crac des Chevaliers: interior of outer southwest tower (from Mesqui)



Although the southwest tower is 16 m in diameter, this would have been reduced by the encroachment of the lower covered level of the parapet. When the quadrangular tower was added, it was given a fighting platform as wide, north to south, as that of the

[1058] This tower is dated epigraphically, Deschamps, *Les Châteaux*, 1:170.

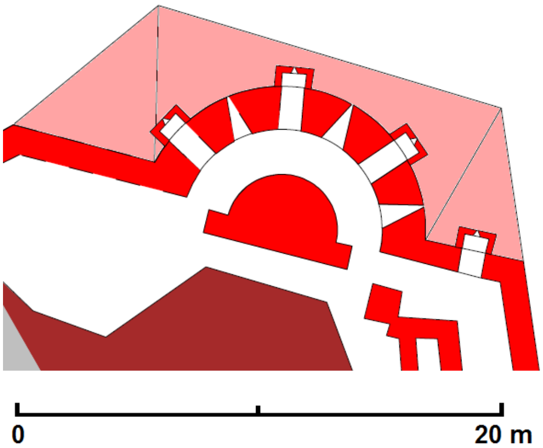
[1059] For a picture of the inside of this tower, see Biller, et al., *Der Crac*, p. 241 fig. 199.

Frankish stables behind the wall. It may have been a desire to mount a larger engine than would fit on the southwest tower that led to the construction of the quadrangular tower. Even with the space occupied by such an engine, there would have been plenty of room for archers along the two levels of the parapet, which extended the length of the southern front. While the raised battlements would also have shielded any lighter artillery positioned on the broader terrace, so too would its lower level protect any within should an engine misfire. The ultimate design of this front provided both strength and protection as well as considerable firepower.

Margat

The Mamluk rebuilding at Margat clearly displays which section of the castle was undermined in 1285. The apex of the outer southern wall was rebuilt with walls 8 m thick. Like the quadrangular southern tower at Crac, the design of the rounded tower is much more solid than earlier ones; however, the glacis around this salient, from which the tower rises, suggests that mining was still the greatest threat and may have been the sole influence behind the thickness of these walls.

Margat: outer southern tower, plan (from Mesqui)



Margat: outer southern tower, from the north (Denys Pringle)

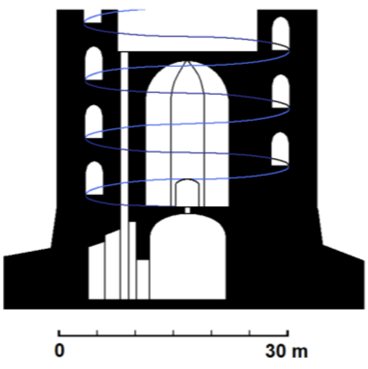
Margat: castle, from the south (Denys Pringle)

The tower has one internal level, servicing three embrasures and three box machicolations, arranged around a large semi-circular pier much thicker than the passage is wide. While stout, there would not appear to have been enough room on this tower to erect any sizable artillery: space rather than strength was the limiting factor here. The internal gallery provided an additional level from which archers could fire outwards but also kept the tower lower than it might otherwise have been. This ensured that it could be commanded from the keep and may have allowed sufficient clearance for defensive artillery to fire over it.

Safed

Space would not appear to have been an issue at the large circular keep built by the Mamluks at Safed, although little remains of this tower today. This massive tower is similar in some ways to the contemporary donjon built at Coucy. Both towers, about 35 m in diameter, appear to have contained a substructure, which limited the amount of central space spanned by their vaulting.[1060] At Safed, it seems a heliocoidal ramp built into the bulk of the outer

Safed: postulated form of the Mamluk donjon, section (after Pringle)

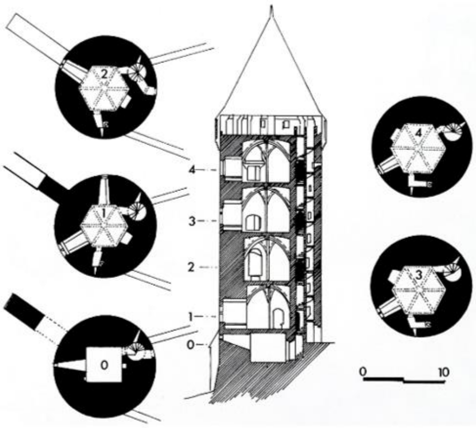


[1060] For studies of Safed, see Pringle, "Reconstructing the Castle of Safad," pp. 139-48; Barbé and Damati, "Le château de Safed," 77-93. For Coucy, see Viollet-le-Duc, *Description du Château de Coucy*.

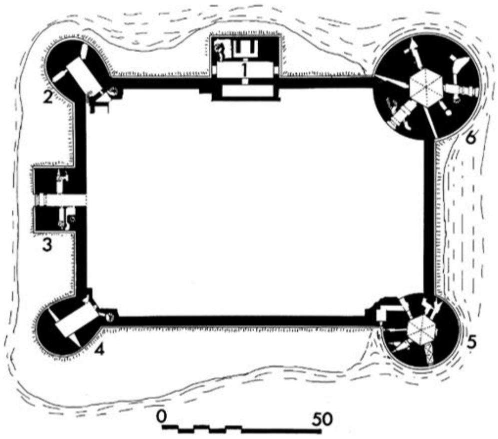
wall ascended the tower, leaving an inner ring of masonry to support the vaulting over what was likely a central open space; however, no illustrative evidence that depicts the interior of this tower has survived.

Like that of Coucy,[1061] the suggested structure of Safed's Mamluk donjon would have made it capable of carrying relatively large loads if it were not for its enormous scale. The probable volume of open space inside these towers suggests that they were designed to impress onlookers rather than to support heavy artillery. Their thick walls, like those of the towers at 'Atlit, were probably a structural necessity. Had the diameter of these towers been smaller, mounting heavy artillery on each might have been an option.

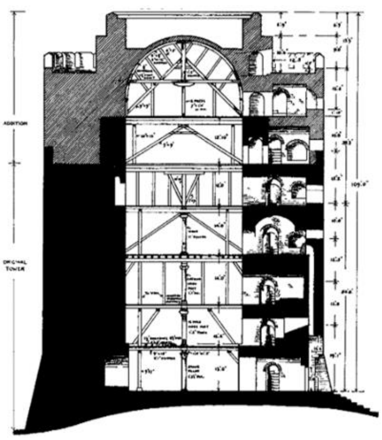
Foix: fifteenth-century round tower, plan and section (from Mesqui)



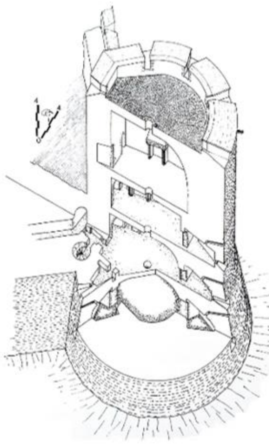
Ham: castle, plan (from Mesqui)



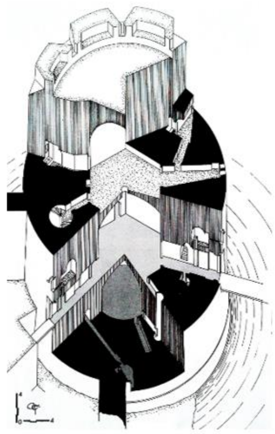
Roumeli Hissar: Black Tower, section (from Toy)



Dijon: fifteenth-century tower, cutaway (from Mesqui)



Ham: fifteenth-century tower, cutaway (from Mesqui)



1061 Plans of Coucy that predate its destruction in 1917 reveal that a single spiral staircase provided access to three lofty internal levels, each with a partial mezzanine level and sheltered by rib vaulting. At the third level, the mezzanine became a gallery by piercing each of the twelve structural pillars, from which the ribs of each level sprang, leaving internal buttresses on the exterior side and solid pillars on the internal side to carry the third vault, which was also the tower's roof.

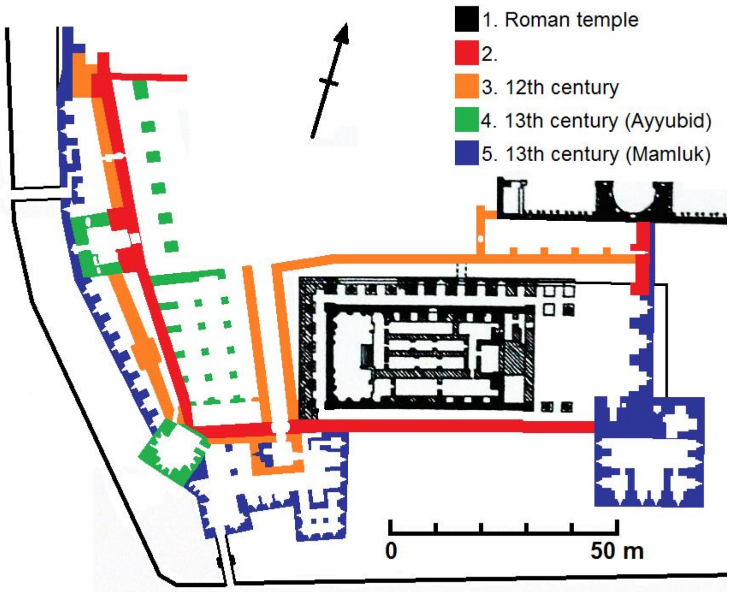
When walls in excess of 5 m become more popular in the fifteenth century, towers tended to be smaller, such as those at Clisson, Foix, Dijon and Bourbon-l'Archambault, all of which were around 15 m in diameter. The exceptionally thick walls of these towers, as well as those of larger towers, as at Roumeli Hissar and Ham, more accurately reflect the growing power artillery, both the increasing strength of offensive gunpowder weapons as well as a desire to incorporate heavy defensive guns in internal casemates.

Others

Most other examples of large Mamluk towers built in the late thirteenth century also seem unlikely to have supported heavy artillery. For example, the exterior wall of the Mamluk donjon at Kerak is impressively thick, but the tower seems to have been only about 15 m deep, suggesting that it was designed to impress onlookers more than anything else.[1062] The numerous embrasures provided for archers appear to be the tower's greatest defensive consideration.

Before Chevedden, Wolfgang Müller-Wiener suggested that the large quadrangular tower built by Qalawun adjoining the temple of Bacchus at Baalbek may have been intended as an artillery platform.[1063] While there is ample space for this and outwardly the tower resembles that at Crac, a wide cross-vault opens up the inside and additional chambers turn what would otherwise have been solid corners into firing chambers. Rather than being intended to support heavy artillery, it appears more likely that a desire to maximise the number of embrasures guided the layout of this tower, as at Subayba's tower 9. The construction of towers E and F at Montreal appear to be similar examples of this, as are the earlier outer towers at 'Atlit.

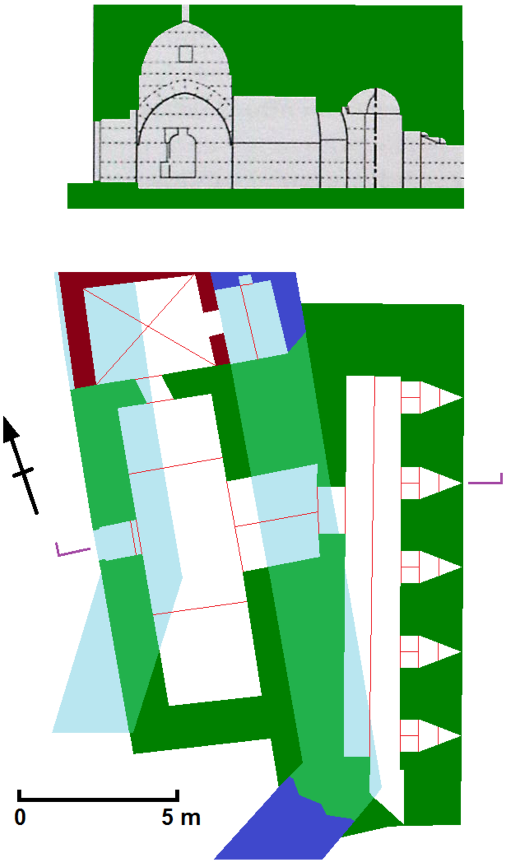
Baalbek: southwestern area of the citadel, plan (after Yovitchitch and Müller Wiener)



[1062] See Deschamps, *Les Châteaux*, 2:88-89.
[1063] Müller-Wiener, *Castles of the Crusaders*, p. 55.

Rather than any new, stronger design, Montreal's tower E is more like the elongated Ayyubid tower at Apamea than most thirteenth-century Mamluk towers.[1064] Likewise, when the southern complex of Shayzar was expanded in the thirteenth century, the addition was laid out more to mimic the earlier structure than to provide any further strength to mount or resist artillery. Thus while there are some examples of towers that might have been able to support heavy artillery, few appear to have been designed specifically to do so. When examining the wider use of central pillars by the Mamluks, Yovitchitch concluded that this was done to provide greater structural cohesion, a countermeasure against mining more than an effort to carry greater loads.[1065]

Apamea: tower 7, section and plan (after Dangles)



Other Interpretations

Structural solutions to supporting greater loads can be quite simple: adding interior supports, such as a crosswall, increasing wall thickness and adding buttressing all work to this end.[1066] Most measures, however, come at a cost to internal space and aesthetic grandeur. While the average thickness of fortified walls increased slightly in the early thirteenth century, so too did vaulted spaces inside towers. Predictably, some of the thickest walls surround the most open internal spaces and, more generally, many of the most impressive structures, whether viewed from within or without, boast thicker than

[1064] See plan in Dangles, "La refortification d'Afamiyya," p. 195.
[1065] Yovitchitch, *Forteresses du Proche-Orient*, pp. 208-10.
[1066] For example, as Anglo-Norman keeps grew taller and heavier through the twelfth and thirteenth centuries, cross-walls were used to divide the lower levels and provide greater stability, evident at sites such as Potchester, Castle Rising, Rochester, Scarborough, Trim and the White Tower.

average walls. Examples range from al-'Adil's encased towers at Cairo to the Mamluk encasement of tower 11 at Subayba, and the great interior towers of 'Atlit to the imposing donjon at Kerak. Aside from monumental projects such as these, the thickness of fortified walls continued to average between 2 and 3.5 m.

Most measures undertaken to increase the defensibility of fortifications in the thirteenth century appear to have focused on maximising the number of embrasures while ensuring structural cohesion, rather than elevating heavy defensive artillery. The solid quadrangular tower at Crac, ideally suited to enduring the stresses associated with mounting such engines, appears to be the only tower both large and strong enough to have accommodated an engine of this type. Solid towers had been built in the Near East in the centuries leading up to the crusades, including those of the Umayyads at Ayla (Aqaba) and those of the Arabs at Minat al-Qal'a, near Ashdod, so their appearance is not proof in itself that they were used to support heavy artillery. The rapid ejection of the Franks from the Holy Land and the region's transition from frontier to hinterland, removed much of the incentive to invest in and develop its fortifications. It is therefore a matter of conjecture whether a larger number of solid towers, such as that at Crac, might have been built if the Frankish presence had lasted longer.

It was not until the fifteenth century and the refinement of chemical propellants that a comprehensive shift in tower design was necessitated, encouraging much thicker walls and solid lower levels in order both to support and to resist improving gunpowder weapons.[1067] The sharpness of this change, relative to any in the thirteenth century, reveals the comparatively limited impact that artillery had on fortification design during the period of the crusades.

Symbolism

The scale of the largest towers was probably intended more to impress onlookers than to perform any particular military function. This is not to say that these buildings were not built to serve a military purpose, only that the size of these towers had more to do with image than a particular aspect of defensibility. The men who built these towers in the early thirteenth century, al-'Adil, al-Zahir Ghazi, the Templars and even Enguerrand III

[1067] See Mallet, "The Transformation of War," pp. 1-17; Pepper, "The Face of the Siege," pp. 33-52; de la Croix, "Military Architecture," pp. 263-90. See also Black, *European Warfare*, esp. pp. 85-86; Parker, *The Military Revolution*, pp. 7-16, 24-32; Dechert, "The Military Architecture of Francesco di Giorgio," pp. 161-80.

of Coucy,[1068] used scale as a form of propaganda, desiring their towers to reflect views of their own grandeur. During the Mamluk period, most towers were smaller than these. The largest accommodate numerous embrasures; however, many still appear to have had a symbolic element, often being striped with inscriptions making it clear for contemporaries and posterity who was responsible for their construction.

Castles and citadels had been used as symbols of control in the Near East prior to the arrival of the Franks, much as they had been in Latin Europe. Although some citadels occupied far older tells, the political importance and medieval fortification of these sites predominantly date to the Seljuk period.[1069] These appear to have been intended to reinforce notions of the social order. Ayyubid, as well as Frankish, fortification efforts can be regarded similarly. In Saladin's shadow, his successors struggled to secure their authority with more than just the sword. Alongside al-'Adil's building programme, al-Zahir Ghazi launched a parallel construction campaign throughout his northern realm. His work at the citadels of Aleppo, Harim, Najm and Mudiq is very similar: each was built on a conical tell faced with masonry and accessed via an impressive gatehouse.[1070] Al-'Adil also employed a stylistic signature through his use of great quadrangular towers, most with a similar drafted masonry style.[1071]

The unprecedented scale of the towers built in the early thirteenth century would remain an influential design option but did not become a new standard. Aside from his impressive gatehouses, al-Zahir Ghazi continued to employ relatively small mural towers, comparable with those constructed a century earlier. Decades later, towers built at Aleppo in the wake of the Mongol conquest were actually smaller than the earlier ones that they replaced.[1072] The continued construction of towers with relatively small footprints contradicts the suggestions of Chevedden and Kennedy that the large towers built by al-'Adil were a necessary response to a dramatic improvement in artillery.

[1068] It is of little influence, but Enguerrand's father, Ralph I of Coucy, died at the siege of Acre in 1191, an episode which thus connects all the parties.
[1069] Rabbat, "The Militarization of Taste in Medieval Bilad al-Sham," pp. 87-92.
[1070] To a certain extent, these resemble the citadels of Hama and Homs, which were rebuilt by al-Zahir Ghazi's cousins. At Harim, al-Zahir Ghazi seems to have encircled the earlier defences, built by the Franks or Nur al-Din, similar to al-'Adil encasement of the Seljuk-Zankid citadel of Damascus. See Gelichi, "The Citadel of Harim," pp. 191-95. Cf. Berthier, "La Citadelle de Damas," pp. 161-63.
[1071] The large tower added at 'Ajlun may also reflect this as it was built by Izz al-Din al-Mansur Aybak, a Mamluk of al-'Adil's son, al-Mu'azzam 'Isa. Another theory aiming to explain the scale of the towers at Damascus suggests that they were built to accommodate al-'Adil's personal fighting force, the *halqa*, Hanisch, "The Works of al-Malik al-'Adil," p. 177.
[1072] Gonnella, "The Citadel of Aleppo," p. 171.

The development of the counterweight trebuchet seems to have had a far from spectacular genesis. While these engines were likely used in the late twelfth century and almost certainly in the early thirteenth, fortification designs may not have been considerably influenced by artillery until the 1270s. But even the changes that occurred during the Mamluk period cannot be compared with the more dramatic shift that took place in the fifteenth and sixteenth centuries.

No one explanation is sufficient to explain the ways in which fortifications developed in and around the Latin East. However, it can be said that the noticeable differences between fortifications built before and after the battle of Hattin were not caused by an attempt to address the threat posed by a new offensive weapon, nor a desire to mount comparable engines on the tops of towers. The transition in Frankish castle building was largely a product of the wealth of the military orders, relative to the Latin baronage, the financial assistance provided by European leaders and the post-Hattin political and military conditions associated with defending inland territory. The founders and developers of these great strongholds were aware of the Franks' limited capacity to relieve a siege. Concurrently, Saladin's heirs were competing for the spoils of his empire. The two main figures to emerge, al-'Adil and his nephew al-Zahir Ghazi, launched building campaigns to project their power and influence. Although the thickness of fortified walls did increase somewhat from the twelfth century to the thirteenth, the use of noticeably thicker walls was far from universal or even consistent. In many instances, exceptionally thick walls appear to have been a structural necessity, often found supporting reciprocally vast vaulted spaces, while a fear of mining inspired the use of such elsewhere.

Conclusions

By investigating the use of artillery in a specific region, over a limited period of time, this study has avoided the temptation to rely on only the most sensational anecdotal evidence, and the inevitable misinterpretations that accompany such a practice. Instead, by diligently examining events on a case-by-case basis, the gradual development of these engines has become apparent as well as the method in which they were employed.

Development

It is clear that artillery was familiar to both Frankish and Muslim forces at the time of the First Crusade. These traction trebuchets were initially fairly light, but their use throughout the twelfth century speaks to their value. Counterweight trebuchets seem to have appeared in the second half of the twelfth century and were probably used by both Frankish and Muslim forces at certain sieges between 1187 and 1192. Initially, these comparatively new engines do not appear to have been significantly more powerful than certain traction trebuchets. However, the introduction of new terminology in the early thirteenth century, around the siege of Damietta (1218-20), suggests that these engines were becoming increasingly distinct as they became more powerful. Unlike most references to artillery from the mid-twelfth century, those identified with new terms, such as *trebuchetum* or *manjaniq maghribi*, tend to be found in limited numbers and at the most significant sieges. Furthermore, these engines tend to be praised for their destructive power, and references to structural damage inflicted by engines identified by other terms gradually disappears.

Physical evidence confirms the increasing scale of the heaviest counterweight trebuchets from the siege of Ascalon (1247) onwards. In 1271, stones around 100 kg were used at Crac des Chevaliers and months later stones over 60 kg appear to have been thrown at Montfort from at least 200 m. Although the mass of the largest projectiles appears to rise through the second half of the thirteenth century and such heavy stones appear in increasing numbers, at most sieges the projectiles thrown by counterweight trebuchets were vastly outnumbered by much smaller ones thrown by traction trebuchets. This is mirrored in the textual evidence from the Muslim side: increasingly specific terminology was introduced to identify new engine-types, but the lightest engines generally made up the majority at a given siege. Thus while counterweight trebuchets grew larger and more destructive through the Mamluk period, traction trebuchets, probably very similar to those used in the early twelfth century, remained in use as antipersonnel weapons.

East-West Supremacy

One readily apparent observation that can be drawn from this study is the similarity between the engines that were used by the various Frankish and Muslim powers. From the First Crusade, to the development of counterweight trebuchets, to the impressive power of some engines near the end of the thirteenth century, the various sources that describe these events, from the Latin East, Europe, Egypt, Syria and Mesopotamia, at no point suggest there was a disparity between the artillery of the Franks and Muslims.

In the past, certain historians have suggested that Muslim artillery was superior to that of their Frankish counterparts in the twelfth century. Such opinions were generally founded on either a belief that siege techniques developed rapidly in Europe during the twelfth century, a result of knowledge brought back from the crusades, or as demonstrated by the successes of the Zankid-Ayyubid reconquests of the second half of the twelfth century.[1073] Gibb, operating from the Muslim perspective, challenged this by identifying the apparent simplicity of Muslim siege tactics in the Near and Middle East before the First Crusade.[1074] Another popular theory has been that the Franks received an education in siege warfare from the Byzantines during the First Crusade. This idea was put forward by Oman and Runciman in much more general terms than Chevedden's more recent artillery-specific theory.[1075] From an opposing point of view, Ronnie Ellenblum has argued that the Franks employed more sophisticated siege engines than did the Muslims

[1073] See Thompson, *Military Architecture*, p. 66; Benvenisti, *The Crusaders*, p. 284; Kennedy, C*rusader Castles*, p. 102; Nicolle, *Crusader Castles*, p. 31.
[1074] Gibb, in Ibn al-Qalanisi, *Dhail*, trans. Gibb, pp. 39-40.
[1075] Oman, *A History of the Art of War*, p. 526; Runciman, *A History of the Crusades*, 1:227-28.

through most of the twelfth century, a sentiment shared by Lynn White Jr.[1076] The work of John France has been critical in amending these skewed interpretations, pointing out that the Franks and Muslims were largely aware of the other side's technologies but preferred different tactics, which were suited to different technologies.[1077] In his study of thirteenth century warfare, Christopher Marshall similarly observed that "the same basic weapons were used by both Muslims and Christians for defence and attack."[1078] The present study can thus be seen as the latest instalment supporting this latter school of thought.

The Muslim invasions of southern Europe during the Early Middle Ages, the Reconquista in Iberia, the struggles between Latin and Greek Christians in Eastern Europe and continual conflicts amongst the powers of these various ethnic groups would have naturally spread the relatively simple mechanics of artillery technology. As any developments were made, their employment in conflict inadvertently shared this advantage with enemies and allies alike. Additionally, more distant links would have been made by travellers, not least those who made pilgrimages to the Levant, accelerating the spread of knowledge amongst the military elites. But when judging the siege technology used by any individual, context is imperative: the resources of the besieging force and its commander, the nature of the fortress to be assailed, the topography, the availability of local timber and even the weather were all critical factors that influenced what engines might be employed at any given siege.

Employment

Almost all previous studies of artillery have operated on the premise that artillery was positioned as far as possible from the intended target.[1079] Although this would have been

[1076] Ellenblum, *Crusader Castles*, pp. 203-30; White, "The Crusaders and the Technological Thrust of the West," pp. 102-3.
[1077] France, "Technology and the Success of the First Crusade," pp. 170-73. See also Rogers, *Latin Siege Warfare*, pp. 62, 244-46.
[1078] Marshall, *Warfare in the Latin East*, p. 212.
[1079] This includes both historical studies and reconstructions, for example, Payne-Gallwey, *A Summary of the History*, pp. 8-10; Chevedden, "King James I," p. 314; Rogers, *Latin Siege Warfare*, Appendix 3, pp. 254-73; Vemming Hansen, "Experimental Reconstruction," pp. 189-208; Krizek, "Trebuchet Reconstructions," pp. 19-20.

ideal in certain circumstances, the evidence suggests that archers could outrange artillery from the start of the twelfth century until at least the middle of the thirteenth. Accordingly, attacking engines were probably positioned so as to optimise their offensive capabilities, taking into consideration factors such as topography and the nature of the besieged site.

Trajectory

Attacking traction trebuchets were probably always operated within range of defensive archers. Counterweight trebuchets may have been among the engines that Saladin erected close to the north wall of Kerak (1183 and 1184), while if counterweight trebuchets were employed at Acre (1189-91), these were also within range of the defenders. As counterweight trebuchets developed, it would have been possible to erect them beyond the range of the defenders. During the Mamluk period, when this option would appear to have been available, the engines used against the citadel of Caesarea (1265) and castle of Arsuf (1265) would appear to have been erected quite close, while at Safed (1266) and Montfort (1271) they may have been positioned beyond the defenders' range. At Beaufort (1268), Crac des Chevaliers (1271) and Margat (1285), certain engines may have initially been situated out of range but were then moved much closer in order to increase the percussive force of their projectiles.[1080] But there would have been difficulties associated with the first attempts to use these engines as breaching weapons.

In order to maximise destruction, the engine involved needs to be as powerful as possible, while the associated projectile should also be as heavy as possible, impact at as high a velocity as possible and at an angle as close to the perpendicular as possible. Collectively these factors required a large engine, firing a large projectile at a low velocity from short range. But moving a large engine is quite difficult and would almost certainly involve going through the time-consuming process of deconstructing the machine to move it closer. An engine large enough to inflict structural damage would almost certainly have been too heavy and cumbersome to move under fire, and it would have been foolhardy to go through the process of erecting such an engine so close to the enemy without first wearing down their defences and numbers. Although most trebuchets were probably fired at an angle greater than 20°, this should not be taken for granted.

[1080] Cf. the engine used in the final phase of the siege of Château Gaillard in 1204, William the Breton, *Gesta Philippi Augusti* 129, ed. Delaborde, p. 219.

Damage

Traction trebuchets were used in an antipersonnel capacity throughout the period of the crusades. When comparing the hypothetical model of an engine at Nicaea (1097), suggested in Chapter 3, with the evidence from the siege of Arsuf (1265), provided in Chapter 7, the power of these engines appears to have increased with time, but not considerably. Assessing the power and degree of damage that counterweight trebuchets were capable of inflicting at a given point in time is more difficult.

When assessing the contemporary descriptions, it is important to bear in mind a sense of relativity: it is easy to undervalue the limited appreciation that such sources would have had of acute structural destruction, compared to modern standards. For example, some sites that are supposed to have been demolished were only mildly slighted. Richard's supposed ability to repair Acre's walls "so they were higher and better than they had been before they were destroyed" in only a month before moving south in 1191, speaks either to the limited degree to which they were 'destroyed' during the siege or an exaggeration of what could practically have been repaired in such a timeframe.[1081]

In some instances, authors would have skewed a sense of reality to impress a point, while in others they may simply have been mistaken or misinformed.[1082] Estimations of an engine's scale, power and rate of fire can also be seen in this light. Whereas previous studies have misinterpreted the power of certain engines by relying on evidence from only a few sieges, often selecting vivid accounts and taking a literal reading of the testimony of a single source, this study has discerned more gradual trends of development by incorporating as many sieges and contemporary perspectives as possible. This approach has allowed the layers of artistic licence to be peeled away.

Datable impact signatures and projectiles provide the most objective measure of the power and scale of the engines they were associated with, but these are only part of a more complex equation. In the absence of timber remains and reliable estimations of scale, the size of a given engine will remain an unknown variable on one side of the equation; however, a sense of this can be deduced by incorporating quantifiable values on the other side. For example, the minimum mechanical energy, the kinetic energy

[1081] *...rex Ricardus muris civitatis operam dabat reparandis in altius et perfectius quam priusquam diruerentur*. Itinerarium, ed. Stubbs, p. 240, trans. Nicholson, p. 227. Cf. letter of Richard I to the abbot of Clairvaux, in Roger of Howden, *Chronica*, ed. Stubbs, 3:131, trans. Riley, 2:222.

[1082] This is similar to the often wildly inaccurate estimations of combatants at a given battle. For a contemporary understanding of such, see Ibn al-Athir, *al-Kamil*, trans. Richards, 2:242. See also Marshall, *Warfare in the Latin East*, p. 212.

transferred to the projectile (EKmin), can be represented if the mass of the projectile (Mp) and distance of flight (R), from which the minimum velocity can be determined (Vmin), are known:

$$\mathrm{EKmin} = \frac{\mathrm{Mp} \cdot \mathrm{Vmin}^2}{2}$$

$$\text{where } \mathrm{Vmin} = \sqrt{\frac{\mathrm{R} \cdot 9.8}{\sin(2 \cdot 45°)}}$$

Similarly, if further investigations are able to quantify the energy required to create a given degree of destruction, this can be used to balance the equation in the absence of other variables:

$$\mathrm{EKmin} = \text{destructive energy} + \text{energy lost in flight}$$

A rough sense of the necessary mechanical energy and capabilities of a particular engine can be used to suggest a rough sense of scale.

Most misunderstandings of these engines are due to an inadequate understanding of the mechanics that govern them. This has allowed for the longstanding overestimations of power and range. While some have misrepresented contemporary material, others have looked ahead to a period where there is more evidence and simply applied this to an earlier context. Among those who have more studiously examined the evidence, Fino has provided a fairly accurate impression of the power of medieval artillery; however, his misunderstanding of the basic operational mechanics of these engines has led to different errors.[1083] Unfortunately, those with the best sense of the mathematics and mechanics are often experts in physics or applied engineering and are not sufficiently familiar with the historical material to place the correct engine size in its appropriate contextual phase of development. In the absence of a comprehensive understanding, misconceptions have become accepted as fact. This has had a knock-on effect and spawned flawed theories

[1083] Fino has suggested that the projectiles of counterweight trebuchets rarely exceeded 100 kg, but appears to underestimate their rate of fire and accuracy, Fino, "Machines de jet médiévales," pp. 36, 38.

regarding the influence of these engines, such as the prominence of artillery as a driving factor behind the development of new fortification styles in the early thirteenth century.

Raglan: slighted keep, from the east (author)

To appreciate the relative ineffectiveness of swing-beam artillery as a breaching weapon, consider that Acre was besieged with such engines during 1190 and 1191 but that most damage was reportedly inflicted in the last month of the siege, following Richard's arrival. Even during this final phase, with a reported nine *perieres*/*petrariae* and two *mangonels*/*mangunelli*, commissioned by some of the wealthiest Latin princes, those who attacked the walls in the last weeks of the siege still required ladders to do so and it was mining that was the greatest threat to the city's walls.

The strength of medieval walls and the effect of sappers are chronically underestimated. The difficulties faced by Saladin in attempting to slight the keep of Jubayl echo what took place four and a half centuries later, when the Parliamentarians turned from gunpowder to the pick in order to slight the 3-4 m thick walls of the keep at Raglan Castle.[1084] Mining was the favoured means of breaching and slighting most strongholds throughout the medieval period, this was as true in 1097 as it was in 1291.

<u>Conjunctive Use</u>

Unlike modern artillery, the medieval artillery used in the Levant during the twelfth and thirteenth centuries was never considered to be the most effective breaching weapon of the day. It was, however, used to assist the sappers who were most often responsible for breaching fortifications. Traction trebuchets provided antipersonnel cover while counterweight engines were used increasingly to affect structural damage: targeting the parapet and upper sections of walls to deny the defenders the use of these positions. If mining alone is considered, artillery can be found providing support at sieges such as Nicaea (1097), Kharput (1123), Jaffa (1123), Edessa (1144), Banyas (1164), Jerusalem

[1084] Wilbrand of Oldenburg, *Itinerarium* 1.6, ed. Pringle, p. 119, trans. Pringle, p. 66. Cf. *Eracles* 25.2, RHC Oc 2, p. 140. See also Conder and Kitchener, *Survey of Western Palestine*, 1:303. The keep still displays cannonballs that were embedded in its walls during the British bombardment of the 1840s.

(1187), Acre (1191), Jaffa (1192), Beirut (1231), Arsuf (1265), Safed (1266), Montfort (1271), Margat (1285), Tripoli (1289) and Acre (1291). Furthermore, examples of its use by Frankish forces support the use of siege towers and Muslim armies to provide cover for massed frontal assaults are equally forthcoming. Topographic conditions usually account for those instances in which artillery was the only type of siege engine used by an attacking force. Due to their range, these engines could often apply pressure against hilltop strongholds, which were inaccessible to siege towers and left sappers exposed.

The psychological impact of artillery is hard to gauge but it was probably considerable. The besieged had to contend with showers of lighter projectiles, which could be cast at the same rate as an archer could loose arrows and would kill or maim anyone in their way. Heavier projectiles would have sent out shockwaves as they collided with fortifications, destroyed internal buildings and crushed individuals like no other weapon could.

It is important to grasp the elemental simplicity of medieval siege warfare. The additional resources that allowed for the construction of newer and stronger defences were the same which allowed traditional ones to be stormed more easily. But as defences and siege engines developed over time, the ladder remained the most effective siege engine throughout the Middle Ages. Later historians have always been influenced by the significance of modern siege technologies. Looking for a reflection of their significance in earlier periods, at times they have failed to accept or acknowledge that overwhelming numbers could carry any stronghold at that time.

Although the heaviest artillery underwent a period of drastic development between the First Crusade and ultimate fall of Frankish Acre, these engines did not have the revolutionary effect that Early Modern siege guns had at the end of the fifteenth century. As fortifications grew stronger, largely as a result of other factors, they were designed under the same guiding principles. Sapping remained the preferred and most effective means of breaching a line of fortifications: those mining under or into masonry, with little more than iron hand tools, were the most significant threat. The romanticised notions put forward by hobbyists and imprudent historians that now characterise swing-beam artillery as a kind of super weapon, a medieval howitzer, must be discarded.

It is my hope that this study has shed considerable light on the use and development of medieval artillery, but it leaves plenty of room for expansion. When I first proposed this project, I had planned to incorporate far more physical evidence from Lebanon and western Syria, adding this to that which has been incorporated from Israel and Jordan. Many of the strongholds of what were the county of Tripoli and principality of Antioch are/were in a reasonable state of preservation, providing a unique opportunity to study the impact signatures, projectiles and rebuilding patters known to be found at some of these sites. The extent to which the current conflict in Syria has forever denied the examination of some of these facets is not yet clear, but this remains an open avenue for further investigation. The integration of dynamic testing stands as a second area in which the current parameters of this study can be expanded. Although stone fracture patterns are difficult to measure, let alone predict, experimental testing would nevertheless provide a better understanding of the immediate circumstances when a projectile collided with a given section of medieval masonry, as well as the longer-term effects of such. I believe that these are both reasonable areas into which I can expand my research, building on the strong textual basis that has emerged from this thesis.

Although I have chosen the crusades as a context in which to examine artillery, the methodology is flexible enough to be applied to different geographic areas and time periods. An easy extension would be to study the use of artillery in Anatolia at the same time, incorporating the Greek, Arabic and Armenian sources as well as various types of physical evidence. Byzantine artillery has been deliberately excluded as much as possible, as the body of Greek material pertaining to this deserves comprehensive examination in its own right. The same could also be done for various European regions. The fundamentals are such that the period in question could be extended to include bombards of the Late Middle Ages and even the first effective lighter siege guns of the Early Modern Period, again pairing source descriptions with surviving impact signatures and guns, altering the mechanical models to reflect the energy produced by chemical propellants.

APPENDICES

Appendix 1.
Illustrative Evidence and Technical Treatises

Few illustrations of European and Near Eastern artillery dating before the twelfth century have survived. Although most images postdate the development of the engines that they depict by many decades, these illustrations serve to confirm many conclusions that have been drawn from the literary sources. These include the initially light nature of traction trebuchets in the twelfth century, the gradual integration of counterweight power systems around the end of the twelfth century and the development of quite sizable engines by the end of the thirteenth century. A number of images will be highlighted here to demonstrate these trends. Where possible, preference will be given to images composed in the Near East; however, in the interest of providing a more cohesive impression of the broader development of trebuchet technology, images from Europe to Persia will be included. When considering that individuals from these wider regions travelled to the Levant, were exposed to the engines that were built there, and that some even imported artillery with them, this broader range of images becomes necessary.

Slings

The staff-sling was a lighter, more adaptable and more mobile option to the traction trebuchet. It was, in essence, a simplified hand-held form of swing-beam artillery: it was operated by a single person, whose body acted like the framework of a trebuchet. Whereas **Figs. A1** and **A2** display a simple sling, those in **Figs. A3-A6** enjoy the mechanical advantage added by the staff component.

Early Frankish Traction Trebuchets

One of the earliest images of a traction trebuchet found west of the Indus comes from Piandjikent, Transoxania (Turkistan), **Fig. B1**.[1085] The wall-painting shows the structure of a traction trebuchet and a team of five pullers. The engine is shown to be constructed of slender materials but is sizable and sturdy: the main axle is approximately twice the height of a man and is supported by four legs, each joined to its neighbour at three points below the axle. Although an early example, the engine's proportions appear to be shown very accurately.

One of the earliest surviving illustrations of a traction trebuchet from Western Europe is **Fig. B2**, a simple beam balanced across the fork of a supporting pole with a short sling, operated by only two pullers. Notably, the engine is depicted in a defensive role. Illustrative evidence from around the Mediterranean becomes more plentiful from the end of the twelfth century.

Peter of Eboli's work contains a number of images of traction trebuchets. **Figs. B3-B11** display these engines at a number of sieges, shown more often in a defensive capacity than as employed by attacking forces. The engines are powered by crews of two to nine and appear to fulfil a similar function as the archers next to which they are frequently depicted. Each engine is structurally light and shown with an axle consisting of two parallel rods, fixed at their ends, between which the beam passes. The tripod bases of the attacking engines, clearly seen in **Figs. B3**, **B4** and **B11**, confirm that these were light engines. In **Figs. B3** and **B4**, as well as **Figs. B16** and **B18-B20**, a loader is shown holding a projectile prior to release, both securing it in place and providing some initial resistance to draw further potential energy from the beam, forcing it to flex before release.

These Normano-Italian illustrations of Peter of Eboli are similar to those found in Skylitzes' contemporary Greek manuscript. **Fig. B12** clearly shows the 'rake' of the short arm, used to secure a broad 'foot' at the end of it, which in turn allowed for the pullers, four in this case, to stand directly under the point where their ropes were attached to the short arm (also visible in **Figs. B3-B6** and **B11**). It appears that the illustrators of the engines in **Figs. B3** and **B12**, understood the range of these machines to be less than that

[1085] For more on this wall art, see Talbot Rice, *Ancient Arts of Central Asia*, pp. 101-10.

of an archer, as attacking archers are shown behind both engines. Furthermore, shielding screens can be seen protecting both the attacking and defending artillery in **Fig. B4**.

Fig. B13 displays a simpler pole trebuchet, apparently what is also shown in **Fig. B14**. These images come from the same document as **Fig. B12** but display engines that appear more like that in **Fig. B2**, apart from their axle arrangements. The similarity of the axles in **Figs. B3-B13**, as well as that in an Italian graffito from the early thirteenth-century, **Fig. B15**, suggest that this design was common in Italy and Sicily, although it is possible that none of these were drawn by an ethnically Italian illustrator.[1086] A number of illustrations from a more French context, **Figs. B16-B20**, reveal a similar set of commonalities; in this case, a simplified axle supported by a vertical upright on each side.

Fig. B16 dates to the early thirteenth century and may represent the trebuchet that killed Simon of Montfort at Toulouse.[1087] The beam of this engine, like those in **Figs. B12**, **B15**, **B19** and **B20**, consists of a main spar supported by two others, which connect either end of the foot, at the end of the short arm, to the main beam beyond the axle. This differs from the engines in **Figs. B3**-**B11**, **B17** and **B18** where the supporting rake structure joins the short arm just in front of the main axle. The former would appear to have been the studier design.

In **Figs. B16**, **B19** and **B20** the foot appears to be aligned vertically. While such an arrangement would minimise the stresses incurred across the foot when the pullers suddenly applied force, it would prevent the outer spars from absorbing some of the strain placed on the main beam where it joined the axle. Furthermore, by aligning the foot vertically, fewer pullers could stand directly below the foot, diminishing the amount of force that could be communicated when the ropes were pulled. It is possible that the illustrators skewed the design of these engines, representing an otherwise horizontal element vertically, in order to show details that would otherwise be hidden from a strictly horizontal perspective.

Figs. B16, **B19** and **B20** clearly show that the pulling ropes were attached to rings that extended from the foot of each engine. When reconstructing his traction trebuchet, Tarver had originally fitted his engine with only three rings, inspired by the latter

[1086] The *Skylitzes Chronicle* was illuminated in Sicily in a Greek style; Peter of Eboli, a Norman, composed his work in either southern Italy or Sicily; and the graffito, found in Tarquinia, mid-Italy, may have been drawn by a Templar, see Pringle, "A Medieval *Graffito*," pp. 37-46.

[1087] For the death of Simon de Montfort, see *Chanson de la croisade Albigeoise* 205, ed. Meyer, 1:341-42, trans. Shirley, p. 172; Roger of Wendover, *Flores historiarum*, ed. Hewlett, 2:252, trans. Giles, 2:426.

illustrations; however, this proved too restricting and he later added five more, two more than are shown in **Fig. B16**.[1088]

Returning to an Italian context, albeit a more northern one, **Figs. B21** and **B22**, from the middle of the thirteenth century, show engines with a similar three-spar arrangement to those in **Figs. B12**, **B15**, **B16**, **B19** and **B20**. The defensive engine in **Fig. B22** appears to have a similar axle arrangement and structure to the southern Italian examples that have been addressed above; however, this assailing engine and that in **Fig. B21** have much sturdier trestle frames. Both of these latter engines also has a substantial foot, with pulling ropes attached at three points. Although the foot of the attacking engine in **Fig. B22** appears to be aligned vertically, the axle, as well as the detailed isometric example in **Fig. B21**, suggest that it has been skewed in order to display it better. The defensive trebuchet in **Fig. B23** appears to have a similar axle to that in **Fig. B22** while its tripod base is very similar to the attacking engines in **Figs. B3**, **B4**, **B11** and **B12**, which also have similar axles. It is hard to discern this artist's influences, as **Fig. B23** was composed in England during the middle of the thirteenth century, around the same time as **Figs. B17-B22** were drawn. The similarities suggest that this design was a popular one around the early twelfth century or that this was just a common way of representing traction trebuchets in artistic-monastic circles.

Three of the earliest surviving editions of William of Tyre's history that contain illuminations of artillery, which were composed in the Latin East, were completed by the early 1280s.[1089] **Fig. B24**, from the earliest and crudest edition, displays a traction trebuchet with trestle-frame in profile. Only one operator is shown but the illustrator may have intended that others were standing beside him, hidden from view. **Figs. B25** and **B26** display heavy traction trebuchets, each with a short sling and a particularly large foot. Each engine is shown with a massive projectile, far too large to be practical. These large stones might reflect the scale of the largest projectiles that were thrown in the late thirteenth century; but, as traction trebuchets, the engines themselves would have been used in the author's day as well as at the siege of Antioch, which is the scene depicted in each image.

The engine in **Fig. B25** is shown with at least seven pullers, who are positioned behind the main axle, like those in **Fig. B16**, while the pullers in **Fig. B26** are well ahead

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[1088] Tarver, "The Traction Trebuchet," p. 156.

[1089] For the relationship between these manuscripts, see Folda, *Crusader Manuscript Illumination*, pp. 27-36. See also Edbury, "The French Translation," pp. 77-90, 97.

of their engine. The beam of each machine is clearly bound. This might indicate that the beams were supposed to be composed of a number of spars, but could also have been done to provide extra strength for a single beam. Tarver found that binding the beam of his engine helped protect it from the metal ring at the end the sling, which had a tendency to swing back against the beam after firing.[1090] The beam of each engine is fitted to an axle that is carried either by a single upright, seated in a base with multiple legs, or, more likely, by two vertical uprights, each with a number of these legs. The use of two solid uprights, rather than a trestle frame, is also found in **Figs. B16** and **B18-B20**; however, the legs of the engines in **Figs. B25** and **B26** would have been very impractical, leaving these engines far less stable than even the tripod designs in **Figs. B3**, **B4** and **B23**. Why the bases of these engines are represented in this way is unclear given the much more structurally sound precedent established in **Fig. B24**.[1091] These are not the only images displaying engines with impractical components.

Fig. B27 contains a traction trebuchet with a single upright and two pullers, similar to **Fig B2**, produced almost two centuries earlier. Although the engine has been implausibly simplified, featuring a cup at the end of the long arm rather than a sling, it appears to reveal how such simple engines might have been employed even at the end of the thirteenth century. On the other hand, machines could be operated by as many as a dozen pullers by this point, as seen in **Fig. B28**, where, despite the added power, the use of shields implies that the range of these engines was still less than that of the defenders. But the illustrative issues with both images, the lack of a sling in **Fig. B27** and obscure axle arrangement in **Fig. B28**, along with those found in other illustrations, are a warning against interpreting these images too literally.

Certain exaggerations can lead to misguided conclusions regarding the power of traction trebuchets. At first glance the heavy foot seen in some illustrations, such as those in **Figs. B16**, **B19-B22**, **B25**, **B26** and possibly **B24**, appear to suggest the use of a small counterpoise, while it is unclear which type of trebuchet the engine in **Fig. C17** represents most closely. Through his trials, Tarver found that his engine, built according to the specifications of al-Tarsusi and using the images found in the Morgan Bible (**Figs. B19** and **B20**), benefited from the addition of a block of wood to reinforce the foot of the machine. This simple addition provided both structural support to an area of high strain

[1090] Tarver, "The Traction Trebuchet," p. 156.
[1091] For the relationship between these manuscripts, see Folda, *Crusader Manuscript Illumination*, pp. 27-36.

and a small amount of extra mass to help balance the beam.[1092] This is the extent to which any hybrid theory can be taken. Hypotheses that a heavier beam could be balanced by a proportionally greater mass and operated by correspondingly large crews ignore the fundamental mechanics that govern these engines.[1093]

Muslim Traction Trebuchets

Mardi ibn 'Ali al-Tarsusi, an Egyptian who may have been of Armenian heritage, provides the most detailed descriptions of Muslim trebuchets during the period of the crusades. Around 1180, he presented a book to Saladin that included a number known and proposed weapon designs, including five types of trebuchets. The simplest was the *lu'ab*, a pole trebuchet that could be easily aimed in different directions and used by a single operator, similar to those in **Figs. B13** and **B27**. This model was so common, according to al-Tarsusi, that it did not warrant illustration. **Figs. B29**, **B30** and **B31** are labelled as 'Frankish', 'Turkish' and 'Arab' mangonels respectively.

The beam of the Frankish model was less than 3 m long and had a ratio of about 6.5:1. Supports joined the foot to the beam at a point 1/3 along its length, with all three spars fixed to the axle for greater stability. The beam is similar to those in **Figs. B17** and **B18** although the point at which the supports join the beam is more akin to those in **Figs. B15**, **B16**, **B19** and **B20-B22**. At the end of the long arm there is a hook rather than a 'finger', quite like to those in **Figs. B3-B11**, **B13**, **B25** and **B26**, which has been skewed to one side in order to distinguish it. The sturdy trestle-structure of this engine, similar to those in **Figs. B21** and **B24**, is shown in profile. Al-Tarsusi recommends that the height of the axle be 3/5 the length of the beam.

The Turkish model, **Fig. B30**, also had a triangular structure in profile; however, the axle is supported independently by the larger of the two struts on each side. It is recommended that the axle should be 3/4 as high as the beam is long. This was the lightest of the engines with a trestle frame and it was praised by al-Tarsusi for its simplicity.

[1092] Tarver, "The Traction Trebuchet," p. 156.
[1093] See Chapter 2.

The Arab model, **Fig. B31**, is slightly more complicated. Its framework was similar to the Frankish model and but its beam had an adjustable hook to alter the engine's range. The effectiveness of this innovation, shown in the illustration, is questionable: having a length of beam extend beyond the hook would risk it interfering with the sling. Al-Tarsusi states that this type of engine was also provided with some kind of a wooden cover to protect its pulling crew, indicating that the engine's effective range was less than that of the opposing defenders.[1094] A sling 1 cubit (0.54 m) long appears to be recommended for each type of engine.[1095]

Al-Tarsusi also gives more general advice regarding the working of traction trebuchets:

> If [the loader] stands directly under the pouch [of the sling], the stone will be very high and [the range] will be short, and it may possibly fall on the [pulling crew]. If [the loader] moves out from the pouch toward the end of the beam by a distance of one span [of a hand, 22-24 cm], the launch will be farther. The most one should move out from the beam is two spans [44-48 cm], [and] no more, for, if one goes beyond this, the launch will be short. The longest distance which the stone can reach is 60 *ba'* [c. 120 m], and the shortest is 40 *ba'* [c. 80 m]. Another principle which determines the farness or the shortness of the distance [of the shot] is the flexibility or dryness of the beam. When the beam is flexible, but not excessively so, it has a farther range and is more effective. When it is dry, it is less so. The shooter should have his feet wide apart, grasp the pouch with his hands, and sit down while he pulls the pouch each time. The best and most proper wood to make the beam is cherry wood. If there is none of this kind, it must be of a closely-knotted wood of intermediate [quality] such as cedar or the like.[1096]

This description provides important details to complement the illustrations, notably the position of the loader and a sense of range. These factors appear to support the power models that have been suggested above – a velocity of at least 34.5 m/s, negating air resistance, is necessary to yield a range of 120 m. This suggests that the engines found in certain images, such as **Figs. B1**, **B3**, **B12**, **B19** and **B20**, are relatively proportionate to the men operating them.

The suggestion that cherry wood was optimal for the beam is sensible but intriguing. Cherry trees rarely have straight branches or even trunks. Writing in Egypt,

[1094] Similar protective screens appear to have been used at the siege of Thessalonica in the sixth century, see *Miracles of St Demetrius*, ed. Lemerle, p. 154.

[1095] For the Arabic, see Cahen, "Un traité d'armurerie," pp. 118-20. For an English translation, see Lewis, *Islam*, 1:219-21.

[1096] Adapted from the partial translation by Paul Chevedden of Mardi ibn al-Tarsusi, *Tabsira Arbab al-Albab* (Oxford, Bodleian Library, MS. Hunt 264), in Tarver, "The Traction Trebuchet," pp. 148-49. For another translation, see Lewis, *Islam*, 1:218-19. For the Arabic, see Cahen, "Un traité d'armurerie," p. 118.

al-Tarsusi probably implied that the cherry, or even cedar, wood would be imported, possibly from Galilee, Lebanon, western Syria, Anatolia or Cyprus, otherwise it would need to be scavenged on campaign. If he meant the former, most of these areas were under Frankish or Greek control when he was writing, speaking to the ongoing trade in materials of war.

Traction trebuchets are also shown in **Figs. B32** and **B33**. Although composed a century after al-Tarsusi's work, the engines seem to be about the same size, each with what appear to be four pulling ropes. Both engines are shown loaded with a pot of incendiaries. Projectiles such as these may have been used at sieges such as Jerusalem (1099) and Acre (1189-91). A much later illustration of a traction trebuchet, from the late fourteenth or fifteenth century, can be found in **Fig. G8**.

Al-Tarsusi's Counterweight Trebuchet

Al-Tarsusi's most famous illustration is that of the 'Persian' mangonel, **Fig. C1**. This is the earliest known image of a counterweight trebuchet and it is accompanied by a description.[1097] All of the fundamental components of the engine are shown, including the beam, counterweight, sling, and even a winch and a trigger. The advantage of this design, according to al-Tarsusi, is that it could produce as much power as a traction model but only required one man to operate it. He states that the power of the engine is 50 *ratls*; however, it is unclear whether the Damascene *ratl* (1.85 kg), Iraqi *ratl* (0.41 kg) or Egyptian *ratl* (0.44 kg) is intended.[1098] If the Damascene measure is intended, this probably refers to the mass of the counterweight (92.5 kg). If the Egyptian or Iraqi measures were used, as might be assumed given al-Tarsusi composed his work in Egypt, it almost certainly refers to the mass of the projectile, since a winch or pulley system would not be needed to lift a mass 20-22 kg.

[1097] For translations of the description, see Appendix 5. For the Arabic, see Cahen, "Un traité d'armurerie," pp. 119-20.

[1098] Bradbury's simplistic interpretation of 50 lbs is inexact at best, Bradbury, *The Medieval Siege*, p. 255. This is the same issue confronting efforts to determine the power of Tughrul's engine at Manzikert in 1054-55, see Chapter 1.

Although al-Tarsusi states that an engine of this type had been made before, the immaturity of the design is clear. Its scale and basic components are comparable to those of a traction trebuchet, if the crossbow is used as a reference. The beam is fixed at a ratio of 3.5:1, mechanically sensible for an engine of this size, and a small counterweight, reportedly suspended in netting, is shown to be connected to the end of short arm by three ropes. The machine's principle design flaw is its low axle. This would have prevented the beam from rotating more than 90° before the projectile was released and would have required a hole to be dug into which the counterweight could fall. The hole would need to be deep enough to allow the counterweight to fall as long as possible before the projectile was released but shallow enough so that the counterweight would hit the bottom before it pulled against the axle with all of the momentum it had built up. Thus, the counterweight would need to reach the bottom of the hole just as, or slightly before, the beam came into line with it, or as al-Tarsusi less precisely states, the ropes connecting the counterweight to the beam should be the same length as the distance between the axle and the bottom of the hole.[1099] This design flaw was subsequently addressed by simply raising the height of axle. This allowed the beam to be loaded at a greater angle and the counterweight to swing freely above the ground after release.

Another issues with al-Tarsusi's design is the placement of the trigger on the back of the sling pouch. If the sling is vertical at the beginning of the firing sequence, the ultimate release velocity will be slower than if it had begun in a horizontal position, extending backwards beneath the beam. If the sling is arranged horizontally, the projectile must travel farther, and thus faster, before release. The greater distance that the projectile must travel and resulting higher rate of acceleration, also allow for the use of a longer sling, which further increases the rate of acceleration and ultimately the projectile's release velocity. Al-Tarsusi's use of a short sling, arranged vertically, and a horizontally cocked beam, probably relate to his better understanding of traction trebuchets, which make use of both. The trigger of this counterweight engine has simply replaced the loader who would otherwise hold the sling pouch of a traction trebuchet in exactly the same way before it was pulled out of his hands.

The most mysterious aspect of al-Tarsusi's design is the incorporation of the crossbow. The text seems to indicate that the tension of the crossbow was used to provide

[1099] If the ropes attaching the counterweight to the beam were the same length as the distance between the axle and the bottom of the hole, the counterweight would always rest on the bottom of the hole.

extra downward force when the engine was fired;[1100] however, the amount of force to be gained in this way would have been negligible. It is also unclear why the crossbow should be loaded before firing, as is stated in the text, if it is to be shot downwards. The crossbow is also linked with the trigger somehow, which is clearly labelled at the opposite end of the engine. In his translation of the accompanying text, Chevedden portrays the crossbow as independent of the trebuchet's firing process: after using the winch to draw back the beam, which also draws back the string of the crossbow, the operator could then shoot the crossbow before firing the engine.[1101] But the crossbow may be far less significant than some have suggested. A considerable portion of al-Tarsusi's work is dedicated to archery and most of the innovative weapons that he presents are traditional weapons that incorporate a crossbow in their design.[1102] Accordingly, the presence of the crossbow is possibly an extension of this exercise: it has been incorporated into an engine that would not otherwise require it. Although al-Tarsusi explicitly states that the engine he describes represents an actual historical weapon, he makes similar claims to this effect when discussing other unlikely weapons.[1103]

Despite the shortfalls of al-Tarsusi's design, the drawing remains the earliest known illustration of a counterweight trebuchet. It is noteworthy that al-Tarsusi emphasises the accuracy of this engine and its ability to be operated by a single man rather than its power. This appears to confirm that knowledge of counterweight trebuchets had spread through the Near East by about 1180 but that these engines may have been only marginally more powerful than contemporary traction trebuchets at this time.

Villard of Honnecourt, Egidio Colonna and Marino Sanudo

Determining the earliest European illustration of a counterweight trebuchet is difficult. The vertical beam of the central engine in **Fig. C2** might suggest that this, and perhaps its neighbours, were counterweight engines; however no counterweights are shown and the

[1100] Fino has supported this apparently literal interpretation, Fino, "Machines de jet médiévales," p. 34.
[1101] See Appendix 5.
[1102] For the archery components, see al-Tarsusi, ed. and trans. Boudot-Lamotte, *Contribution à l'étude de l'archerie musulmane*. For some of the innovative designs, see also Cahen, "Un traité d'armurerie," pp. 103-63.
[1103] Other examples include a lance with a crossbow at the end and shield with a crossbow built into it.

structure of these engines is the same as the traction trebuchet in **Fig. B22**, which is found on the previous folio of the same manuscript. A drawing by Villard of Honnecourt, with an accompanying description, appears to be the first conclusive drawing of a counterweight trebuchet, even if the most essential components are missing.

Villard of Honnecourt

Among the various sketches of Villard of Honnecourt is the footprint of a counterweight trebuchet, **Fig. C3**;[1104] unfortunately, the accompanying elevation has not survived. The description reads:

> If you want to make the strong engine that is called a trebuchet, pay close attention here. Here is the base as it rests on the ground. Here in front are the two windlasses and the double rope which one draws back the shaft [beam] as you can see on the other page. There is a great weight to pull back, for the counter-poise is very heavy, being a hopper full of earth which is two 'large toises' [roughly 'two fathoms' or about 12 pieds/feet] long and nine feet across and twelve feet deep. Remember the arc of the arrow when discharged and take great care, because it must be placed against the stanchion in front.[1105]

The size of the counterweight box has attracted considerable attention. This is the best indication of the size of the engine, but the lack of standardised measurements, the absence of a clear sense of scale and missing illustration of the counterweight box have left this open to interpretation. Chevedden has argued that the counterweight box would have had a volume of about 18 m^3, allowing it to hold up to 3 tons. This, according to Chevedden, would allow it to throw a 100 kg projectile more than 400 m or one 250 kg more than 160 m; if the mass of the counterweight was halved, it would still be sufficient to hurl a 100 kg projectile over 200 m or one 60 kg over 350 m.[1106] Fino believed that the counterweight box might have been able to hold 26,000 kg of earth – suggesting that this might correspond with a beam 10-12 m long, with a ratio of 3:1. With this in mind, he calculated that two treadwheels, about 4 m in diameter, with accompanying pulleys would

[1104] The dating of this image is not clear, Paul Chevedden dates this work to between 1220 and 1240 while Jim Bradbury and John France date it c. 1270, Chevedden, "Invention," p. 72; Bradbury, *The Medieval Siege*, p. 263; France, *Western Warfare*, p. 121.

[1105] *Se ù voles faire le fort engieng con apiele trebucet prendes ci gard. Ves ent ci les soles si com il siet sor tierre. Ves la devant les .II. windas et le corde ploie a coi on ravale le verge, veir le poes en cele autre pagene. Il i a grant fais al ravaler, car li cõtrepoise est mlt pezans. Car il i a une huge plainne d'tierre. Ki .II. grans toizes a d'lonc et .VIIII. pies de le, et .VII. pies de pfont. Et al descocier de le fleke penses, et si ù en dones en dones gard. Car il le doit etre atenue a cel estancon la devant.* Trans. adapted from those of Lassus, *Album*, p. 203 and Contamine, *War in the Middle Ages*, p. 103.

[1106] Chevedden, "Invention," p. 72, see also n. 3.

be sufficient to lift the massive counterweight.[1107] Using the modern 12 inch foot, Bradbury has interpreted the capacity of the counterweight box to have been an enormous 1,296 ft^3 (36.7 m^3).[1108]

An engine capable of both producing and withstand the forces involved with a counterweight of over 25,000 kg, perhaps about 1.5m x 4 m x 4 m (rendering a total, rather than internal, volume of 24 $m^{3)}$, would have been huge. I know of no modern reconstructed engine with a counterweight even half this size, and when considering the troubles encountered by Louis-Napoleon and Harvé with their engine in the eighteenth-century, which had a counterweight less than 20% of the size, it seems unlikely that such a large engine was ever built and practically employed during the thirteenth century.

The date of Honnecourt's work is debated. Chevedden places its production between 1220 and 1240, Bradbury and France date it to around 1270, and Fino attributes it more generally to the mid-thirteenth century.[1109] Although the accompanying sketch of the elevation has been lost, the base plan has been the inspiration for Viollet-le-Duc's nineteenth-century interpretations (see **Figs. H3** and **H4**) and many modern reconstructions.

Egidio Colonna

Egidio Colonna composed his *De regimine principum* for Philip IV of France around 1280. Within, he describes four types of trebuchets: traction models, which are praised for their rate of fire but noted as being incapable of throwing heavy stones; the *trabutium*, which had a fixed counterweight and is praised for its accuracy; the *biffa*, which had a mobile counterweight and is praised for its range; and the *tripantum*, which had both a hinged and a fixed counterweight, allowing it to be more accurate than the *biffa* with a range greater than the *trabutium*.[1110] Although Egidio Colonna correctly observed that a trebuchet with a hinged counterweight would have had a greater range than a similar engine with a fixed counterweight, neither would have enjoyed an advantage in accuracy.

[1107] Fino, "Machines de jet médiévales," p. 34.
[1108] Bradbury, *The Medieval Siege*, p. 263.
[1109] Chevedden, "Invention," p. 72; Bradbury, *The Medieval Siege*, p. 263; France, *Western Warfare*, p. 121; Fino, "Machines de jet," pp. 33-34.
[1110] Egidio Colonna, *De regimine principum* 3.3, ed. Samaritanium, pp. 604-6, ed. Hahn (as chap. 18), pp. 50-52. For a French translation of this section, see Bonaparte, 2:29-30.

The description of the *tripantum's* movable counterweight has left it open to interpretation.[1111] Bradbury, possibly influenced by Oman, has suggested that this mass could be moved along the length of the short arm, so as to adjust the engine's range. Hill judged this instead to describe a traditional hinged box counterweight that could be rotated (essentially propped) to start above the end of the short arm, possibly inspired by **Figs. F9**, **F11** and **F23**.[1112] Hill acknowledged that his interpretation of a rotating counterweight would be impractical due to the additional stresses that such an arrangement would introduce. Cathcart King simply suggested that Egidio's descriptions were fanciful.[1113] It is possible, however, that Egidio overcomplicated his description of what was otherwise an engine that had both a weighted short arm (fixed counterweight) and a hanging weight: like that of any other trebuchet with a hanging counterweight, the hinged component would rotate the better part of 180° around the end of the short arm during the course of a firing sequence. Counterweight trebuchets with a weighted short arm and hinged counterweight are featured in images **Figs. C7**, **F5**, **F6**, **F27** and **F34**. Marino Sanudo's early fourteenth-century description of contemporary artillery provides another perspective.

<u>Marino Sanudo</u>

In his suggestions for how the Holy Land might be retaken for Latin Christendom, Marino Sanudo provides a fairly detailed description of artillery, as he understood it. He distinguishes between two types of engines, the common variant and a long-range model. He describes the former as the following:

> The hips of a machine ought to be as broad on the ground as the height of the machine at its tip and underneath the said machine ought to be open on the ground, between 2 hips minus a third part [of its height]: that is, if the aforesaid machine is 24 feet at its highest point, it ought to be 16 feet on the ground. The masters divide the main pole of the machine from the weighted bottom to the tip into 5 or 6 parts and place the sow [axle] between the fifth and the sixth [part], so that if the pole is 30 feet long from top to bottom, that is 5 or 6 feet, and the fifth is 6 feet, and the sixth above-mentioned as is seen will be 5 feet. Concerning which thing, the cross-bar of the

[1111] *Aliud genus machinarum habet contrapondus mobiliter adhaerens circa flagellum, vel circa virgam ipsius machinae, vertens se circa huiusmondi virgam*. Egidio Colonna, *De regimine principum* 3.3, ed. Samaritanium, p. 605.

[1112] Bradbury, *The Medieval Siege*, p. 267; Oman, *A History of the Art of War*, pp. 543-44; Hill, "Trebuchets," p. 105.

[1113] King, "The Trebuchet," pp. 463-64.

> catapult ought to be placed five and a half feet from the cross-bar of the container mentioned above.[1114]

What he appears to be describing is a fixed-weight counterweight trebuchet with a beam, at a ratio of either 5:1 or 4:1, mounted on a trestle frame.[1115]

The long-range trebuchet is similar. It also has a beam with a ratio of 5:1, again given a hypothetical length of 30 feet, but it had a container attached to the end of the short arm rather than a fixed counterweight. The common engine thus appears to correspond with Egidio Colonna's *trabutium* and the long-range type with the *biffa*. Although Sanudo recommends that the container of the long-range model be as big as possible, so as to allow the engine to throw projectiles as large and as far as possible, he asserts that the scale of the machine determined the appropriate mass of the counterweight, which in turn determined the size of the projectiles. Revealing his familiarity with these engines, he adds that the range of an engine could be altered by adjusting the iron 'finger' at the end of the long arm.[1116] This detail suggests that he, or someone close to him, understood how a counterweight trebuchet operated in practice.

Although Sanudo gives the impression that these engines were quite large, he claims that they were deployed on ships and even seems to imply that their use on land was secondary. This is probably influenced by the Venetian naval tradition that would have been prevalent around him, but also seems to confirm Abu'l-Fida's claim that an engine mounted on a ship assailed his forces at the siege of Acre in 1291.[1117] Sanudo states that the counterweight would hang over the side of the vessel when the engine was cocked and would then swing down through a channel across the middle of the boat when fired.[1118] The scale of such engines would necessarily have been limited, due to the shortage of available space on-board these vessels and the dynamic forces that accompanied the fall and swing of a counterweight. Marino Sanudo admits that he was

[1114] Marino Sanudo, *Liber secretorum* 2.4.22, ed. Bongars, pp. 79-80, trans. Lock, p. 135.

[1115] If the height of the axle is meant to correspond with the height of the frame, it is impractically high relative to the length of the beam. With a 4:1 beam, the length of the long arm would be the same as the height of the axle; with a ratio of 5:1, if the engine was loaded with the tip of the long arm touching the ground, the beam would be at a angle of almost 164°. The added strain incurred as the counterweight was pulled outward, as the short arm rotated downward, and then inwards, as it continued to rotate, would make this engine relatively unstable. Few contemporary illustrations show trebuchets loaded beyond about 140° and I know of no sizable reconstructed engines that are loaded to an angle greater than this.

[1116] Marino Sanudo, *Liber secretorum* 2.4.22, ed. Bongars, p. 80, trans. Lock, pp. 135-36.

[1117] Abu'l-Fida', *al-Mukhtasar*, trans. Holt, pp. 16-17

[1118] Marino Sanudo, *Liber secretorum* 2.4.22, ed. Bongars, p. 80, trans. Lock, p. 136, cf. 2.4.6, ed. Bongars, pp. 57-58, trans. Lock, p. 104.

not a military man but his descriptions, along with those of Egidio Colonna, clearly convey that counterweight trebuchets were far from novel by the end of the thirteenth century, something confirmed by the illustrative evidence from this period.

Frankish Counterweight Trebuchets

Returning to illustrative sources, simple counterweight trebuchets are found in **Figs C4** and **C5**. The frames of these engines are similar to those in **Figs. B16** and **B18-B20**. Each has a beam with a ratio of about 4:1, a counterweight that resembles a barrel and a short sling, which is drawing the projectile out from under the engine.[1119] Although the framework and sling of each machine appears more suited to a traction engine, the basic mechanics of a counterweight trebuchet are obviously known to the illustrators of these images. Sturdier trestle-frames and more familiar triangular counterweight boxes are found in **Figs. C6-C8**. The slings of these engines are more proportionate, although the trebuchet in **Fig. C8** has no short arm. The beams in **Figs. C6** and **C8** appear to be composed of multiple spars and all three engines have a trough along which their projectiles would slide before being lifted into the air. The framework of the engine in **Fig. C8**, which was drawn in Acre only months before the city fell in 1291, is very similar to that of al-Tarsusi's 'Frankish' engine, **Fig. B29**, while that of the engine in **Fig. C7** is very similar to some of those found in editions of Konrad Kyeser's *Bellifortis*, composed well over a century later (see **Figs. F8** and **F9**).

Although one of the reconstructed trebuchets at Castelnaud has a similar scale to the engine in **Fig. C6**,[1120] the engine in **Fig. C9** would appear to represent more accurately the scale of the largest counterweight trebuchets at the end of the thirteenth century. The vast majority of illustrations featuring trebuchets, however, depict engines with a scale similar to that in **Fig. C10**, relative to its loader. This might indicate that most counterweight trebuchets had axles no more than about 3 m high in the thirteenth century, which would help to explain the frequency with which engines are shown with extremely frail frames. But this would imply that the illustrators had a fairly good sense of their

[1119] A similar reconstructed trebuchet, notably with a barrel as a counterweight, can be found at King John's castle, Limerick.
[1120] For photos of this reconstructed engine, see Norris, *Siege Warfare*, figs. 104, 105, p. 200.

subjects, which may not have been the case, and does not explain references to what appear to have been quite substantial engines around the end of the thirteenth century, such as those used at Acre (1291) and Stirling (1304).[1121]

Extremely light trebuchets are found in **Figs. C11-C13**. The Parisian artists of these machines appear to be familiar with the basic concept of a counterweight trebuchet but not the broader mechanics, as there are no outriggers supporting the vertical struts nor is it clear if these are pole trebuchets or if a second strut is hidden from view due to the profile perspective. **Figs. C14** and **C15**, from a contemporary Parisian manuscript, reveal an even poorer understanding of trebuchet technology. Images such as these remind us of how few monastic illustrators would have actually seen one of these engines. The counterweight pole trebuchets in **Figs. C14** and **C15** would have been completely impractical and the proportions of various components confirm the illustrator's ignorance. Similar issues can be found with the engine in **Fig. C16** and even more problems can be seen in **Figs. C17** and **D18**. The apparent hybrid trebuchet in **Fig. C17** should not be considered any more historically accurate than the engines in **Fig. C18**: one uses a rooted tree as its supporting frame and the ropes of the sling and counterweight of the other are simply looped over either end of the beam. There are also examples of both accurate and inaccurate illustrations of trebuchets with fixed counterweights.

One of the earliest surviving European illustrations of a fixed counterweight trebuchet, **Fig. C19**, is found in an edition of William of Tyre's history that was composed around 1270. The illumination appears to show two pole-framed trebuchets throwing heads towards the defenders of Nicaea. The beams have a ratio of about 1:1 and at the end of the short arms there is a bulge, large enough to suggest that these are intended to be counterweights but small enough to leave it open to possibility that these were meant to be traction engines, albeit with the most important elements omitted. Whatever the illustrator's intentions, the image reveals his lack of understanding. By contrast, the *tripochen* in **Fig. C20** reveals greater understanding of the mechanics, although it is drawn with a more primitive sense of perspective.[1122]

[1121] For the siege of Stirling, see Peter of Langtoft, *Chronicle*, ed. and trans. Wright, pp. 356-59; Freeman, "Wall-Breakers and River-Bridgers," 13-15. Cf. Bain, ed., *Calendar of Documents Relating to Scotland*, nos. 1,491, 1,498-500, 1,504, 1,510, 1,519, 1,539, 1,560, 1,599, pp. 387, 388-89, 390, 395, 400, 405, 419-20.

[1122] Cf. Marino Sanudo's description of a *tripantum* above and the *tribok* and *tribracho* noted respectfully in *Cronica Reinhardsbrunnensis*, ed. Holder-Egger, p. 58, and *Chronica S Petri Erfordensis*, ed. Holder-Egger, p. 383. See also Chapter 1.

More accurate illustrations of fixed counterweight trebuchets are found in **Figs. C21** and **C22**. The two miniatures show an engine in the process of being set up and then complete and loaded. The engine has a sturdy trestle frame and a beam with a 2:1 ratio. This engine, and what appears to be a traction pole trebuchet in the background of **Fig. C21**, appears to have a scale similar to previous examples. This counterweight engine stands in contrast to that in **Fig. C23**. Unlike the reasonable beam ratio and sturdy frame of the former, the latter has an unrealistic beam ratio of 1:2 and a frail frame similar to those in **Figs. C4**, **C5** and **C10**. In other examples, illustrative issues go beyond the structural strength of the framework and impractical beam ratios.

Illustrative Confusion

Neither of the engines in **Figs. D1** and **D2** appears to have a short arm or counterweight: in **Fig. D1** the beam ends at the axle while in **Fig. D2** the end of the beam appears to rest on top of the axle. Perplexingly, these engines were drawn by the same hand(s) as those in **Figs. B25** and **B26**. It is unclear what the mysterious circle shown ahead of the engine in **Fig. D1** is supposed to be: it may be a winch, although against what this would have drawn the long arm back is unclear; it may be a strange interpretation of a counterweight; or it may be some kind of a defensive screen to protect the engine. Given its numerous issues, it is even possible that the illustrator combined what he had read about classical torsion engines with a basic understanding of the framework of a swing-beam engine. **Fig. D2** appears to postdate **Fig. D1** and the illustrator has not included the mysterious circle. Due to the damage, it is hard to tell whether the trebuchet in **Fig. D2** was meant to have a counterweight hanging below the axle similar to that in **Fig. C8**, which was also completed in Acre but about ten years later. A different set of peculiar engines are found in a slightly later manuscript of William of Tyre's chronicle.

Fig. D3 seems to show a traction trebuchet, similar to those in **Figs. B17** and **B18**, with a beam like that in **Fig. B29**; however, the ropes of the pullers appear to be restraining the long arm, rather than being connected to the foot of the short arm. **Fig. D4** contains a very similar engine, but the team of pullers, again appearing to restrain the long arm, are positioned under the main axle and what appears to be a small weight has been hung from one end of the foot at the end of the short arm. This weight might be seen as balancing the beam if it were not for the obvious efforts of the three men to pull down the long arm. These images appear to be another example of an illuminator combining elements of traction and counterweight trebuchets. In this case, the illustrator would appear to have drawn inspiration from images he had seen of traction trebuchets and mixed in what he understood or had heard about counterweight trebuchets.

Figs. D5-D7, completed around the same time as **Figs. D3** and **D4**, contain engines similar to that in **Fig. C10** but at the end of the long arm of each engine there is a cup rather than a sling. Although it is unlikely that engines without slings were used widely, if at all, from a mechanical point of view, this would have been the best arrangement to throw an extremely heavy projectile, relative to the mass of the counterweight, a short distance. While it is tempting to view these cups as another example of the ignorance of most illuminators, it is possible that the illustrator has provided a rare glimpse of a specific, if rare, engine-type, perhaps described to him by someone who had seen one first-hand.

Defensive Counterweight Trebuchets

All of the illustrations of counterweight trebuchets introduced thus far have depicted engines in an offensive capacity, with the possible exception of **Fig. C9**. If the trebuchet in **Fig. C9** is meant to be within a fortified enceinte, rather than behind one, it is clearly positioned on the ground rather than on top of a tower or section of wall, similar to that in **Fig. E1**. Both of these early fourteenth-century images reveal engines that are much larger than most of those found in manuscript illuminations. The engines appear to be portrayed in proportion to the architecture around them and clearly reveal the issues associated with attempting to mount a counterweight trebuchet on top of a tower.[1123] The impractically small trebuchet in **Fig. E2** should not be viewed as a counterpoint. This image depicts the Roman siege of Jerusalem and the trebuchet found on top of the walls represents the classical engines that Josephus describes firing from the city's defences.[1124]

[1123] For the positioning of defensive engines, see Chapter 8.
[1124] See Josephus, *The Jewish Wars* 5.6, trans. Whiston, pp. 810-11.

A very large defensive counterweight trebuchet is shown in **Fig. E3**, which dates to the early fifteenth century. The machine appears to have been designed, or is at least presented, so that the struts of the engine abut the curtain, allowing the counterweight to hang over the wall when the beam is cocked. Although the trebuchet in **Fig. E3** is certainly out of scale, some engines may have been designed specifically for defence. Whereas traction engines were well suited to be placed on top of towers, for which there is considerable illustrative evidence, counterweight engines are rarely depicted in elevated defensive positions.

Late Medieval and Renaissance Illustrations

European illustrations of trebuchets become more accurate, in general, from the second half of the fourteenth century. **Fig. F1**, which slightly predates this point, has a number of issues but nevertheless seems to show the engine to scale with the operator/observer. The number of mechanical and structural issues decrease with time as knowledge of these engines spread beyond the military elements of society and permeated deeper into artistic circles. **Figs. F2-F6** come from various parts of Europe and although each has certain simplifications and slight inaccuracies, such as the chronically undersized counterweights, the trestle framing and general proportions of the various components reveal that their creators had a greater degree of understanding or perhaps even exposure. Furthermore, the potential scale of such engines is indicated in **Figs. F2**, **F5** and **F6**. Although accuracy increased through the fifteenth century, certain exceptions can still be found. For example, **Fig. F7**, contains a small and simplistic trebuchet.

As the significance of swing-beam artillery was ebbing, broader social changes, greater communication and advances in mechanical science led to increasingly accurate images in the fifteenth century. **Figs. F8-F11**, from various copies of Konrad Kyeser's *Bellifortis,* epitomise this. **Fig. F8** includes the measurements 46 and 8 for the long and short arms of the beam respectively. Chevedden has interpreted these measurements to be in 'workfeet', each 0.288 m, giving the beam a total length of about 15.5 m and a ratio of 5.75:1.[1125] Despite these schematic details, the illustration has a number of significant

[1125] Chevedden, "Invention," fig. 3.

errors: the trough has a lip, as in **Fig. F3**, and both ends of the sling appear to be fixed to the beam, which is not provided with a finger. A major design flaw that runs through Kyeser's plans is the use of a cuboid counterweight box, similar to those in **Figs. F2**, **F3** and **F6**. These require that the struts of an engine be set widely apart in order to allow the box to swing between them. This is exasperated by the need to minimise strain on the axle by limiting the space between the beam and housing on each side. The steep angling of the struts is evident in Kyeser's measurement of 23 (6.6 m according to Chevedden) between them at ground level. If the struts are vertical, the forces exerted upon them during the firing sequence are relatively two-dimensional while angling them introduces torque and increases the strain exerted through the framework.

Fig. F9 presents a more schematic view. The beam is increased by two units to produce an even ratio of 6:1 and a finger, albeit of wood, has been added. Although the counterweight is shown in a more familiar triangular shape, the outline makes it clear that this is just a cross-section of the same cuboid design shown in **Fig. F8**. The engine is also given a prop to raise the counterweight higher as the beam is rotated into a cocked position. This would prevent the counterweight from falling as straight during the firing sequence; however, the added height would provide greater power as long as the projectile was released before the beam reached about 30° to the vertical, at which point the counterweight would retard the rotation of the beam given the proportions of the short arm and counterweight.[1126] The degree of detail found in this image, such as the composite beam, which is pinned and lashed together, stands in contrast to those in other editions of *Bellifortis*, such as **Figs. F10** and **F11**.

Despite the apparent accuracy with which **Figs. F8** and **F9** were drawn, *Bellifortis*, like al-Tarsusi's treatise, contains a series of novel and impractical weapons. Although the trebuchet was certainly a familiar siege engine across Europe by the fourteenth century, Kyeser may have exaggerated the scale of his engines and added certain elements with the intent of improving an already familiar design. An engine, similar to Vegetius's *tollenno*,[1127] is suggested in **Fig. F13** as a means for crossing rivers. This engine has a beam almost identical to that shown in **Fig. F12**. This theme of experimentation can also

[1126] For a mathematical representation of a propped counterweight, see Siano, *Trebuchet Mechanics*, pp. 32-34.

[1127] Vegetius, *Epitoma Rei Militaris* 4.21, ed. Lang, pp. 142-43. See also Roberto Valturio, *De Re Militari* (Paris: BNF, MS lat. 7236), f. 133r; Francesco di Giorgio, *Trattato* (Turin, Biblioteca Reale, Cod. 148 Saluzzo), f. 60r.

be seen in **Fig. F16**, where a counterweight trebuchet, like those in **Figs. F14**, **F15** and **F17**, is shown among other methods of delivering incendiaries. The broader interest of Renaissance figures such as Mariano di Jacopo Taccola, Roberto Valturio and Francesco di Giorgio in practical and imagined designs of trebuchets can be seen in **Figs. F14-F33**. Although accuracy continues to increase into the late fifteenth century, some depictions still included simple design flaws, such as the insufficiently high axle in Kolderer's famous woodcut (**Fig. F34**).[1128]

The engines in **Figs. F23-F26**, from Roberto Valturio's 1463 edition of *De re military*, have formed the essential basis of our modern conceptions of the various types of counterweight trebuchets. There was little development technologically beyond this point as swing-beam artillery would be completely eclipsed by gunpowder artillery before the end of the century. Despite the waning importance of these weapons, even Leonardo da Vinci experimented with new designs, as seen in **Figs. F32** and **F33**, presumably drawn during his period of service with Ludovico Maria Sforza (1483-99) or Cesare Borgia (1502-3). But while there is relatively plentiful illustrative evidence to trace the ways in which counterweight trebuchets were drawn in Western Europe from the thirteenth century, comparatively few Muslim images have come to light.

Muslim Counterweight Trebuchets

Following al-Tarsusi's illustration of a counterweight trebuchet in the late twelfth century, evidence from Persia confirms that trebuchet technology in the Islamic world had been significantly refined by the end of the thirteenth century. **Figs. G1** and **G2** clearly show counterweight trebuchets with trestle frames and beams with ratios of 10:1 and 4:1 respectively. The counterweight of each engine appears to be a solid mass hung with ropes from the end of the short arm. Like the traction trebuchets in **Figs. B32** and **B33**, these engines are loaded with incendiaries rather than stone projectiles.

More familiar container counterweights can be found in **Figs. G3-G5**, which date to the early fourteenth century. The detailed engine in **Fig. G5** appears to have a slightly heavier framework than the other two, but all appear to be drawn extremely accurately.

[1128] For Cathcart King's interpretation of this engine, see King, "The Trebuchet," p. 467.

The degree of detail may even suggest that the engines were drawn to scale with the men around them. If so, they would appear to have axles approximately 2.5 m high and beams about 3 m long. Although this seems slightly small, the scale is very similar to that in many of the European illustrations. Whether intended or not, the large beam ratios, 10:1 and 7:1, and long slings of the engines in **Figs. G3** and **G4** would have made them particularly well suited to throw light projectiles considerable distances. By employing a short small arm, a significant counterweight is necessary, as the distance that it can fall is limited. Placing the counterweight close to the axle limits the strain on the beam, allowing the use of a slender beam. A long but light beam, when fitted with an equally long sling, maximises the distance that the projectile must travel before release, and thus maximises release velocity. These proportions are ideal so long as the projectile is very light: the retarding force of any mass on the opposite side of the axle from the counterweight is amplified in proportion to the shortness of the small arm. Accordingly, there is no issue with the projectile in **Fig. G3** but those in **Fig. G4** are far too large for the engine.

Similar engines can be seen in the two-page depiction of the Mongol siege of Baghdad in **Fig. G6**. Of the three counterweight trebuchets, the engine in the bottom left corner seems to be heavier than the other two. The framework of this trebuchet is more like that of the engine in **Fig. G5**, while the other two, with at least five outriggers gathering at the axle, are more like those in **Figs. G3** and **G4**. The heavy engine also has a winch, like those in **Figs. G3-G5**, while the other two were presumably light enough that their beams were drawn back by hand, sacrificing power for a higher rate of fire.

A similar scene is displayed in **Fig. G7**. The two engines are again counterweight trebuchets but appear to be lighter than any of those in **Fig. G6**. These trebuchets also appear to be cocked by hand as the machine on the left seems to have three men pulling the beam back and the one on the right has a single man drawing back the beam while his colleague prepares to load a projectile. The wheels at the rear of each engine's trusses might be there to help manoeuvre the machines or they are meant to be winches, which the artist seems to have misunderstood when adapting them from an earlier illustration. While these illustrations help to confirm the widespread use of these engines, it is necessary to consult a fifteenth-century source for the full range of swing-beam artillery types.

Yusuf ibn Irinbugha al-Zardkash's treatise on trebuchets can, in some ways, be seen as a parallel to the work of Roberto Valturio in its treatment of these engines. **Fig.**

G8 shows a traction trebuchet with a single pole support and two short arms that diverge as they extend back from the axle. The two short arms spread the pulling ropes and provide more room for the pullers, similar to the raking structure of many European examples, while the single vertical support allows the beam to yaw and aim at different targets without rotating the whole machine. The engine in **Fig. G9** acts on the same principle but makes use of counterweights rather than traction power, similar to **Figs. F18-F20**, **F24**, **F26** and **F29**. The trebuchet in **Fig. G10** has a more traditional trestle frame and a 4:1 beam ratio. Its hanging counterweight appears to be solid and is shown at an unnatural angle, similar to those in **Figs. G1**, **G2** and even **C8**. The beams of all three of al-Zardkash's trebuchets, as well as that in **Fig. G11**, are bound in a familiar manner and a finger clearly extends from the end of each long arm. As the heaviest of the assembled engines, that in **Fig. G10** appears to be fitted with a winch, shown as the circle at the bottom front corner of the frame, similar to that included in **Fig. G11**. While these engines are quite straightforward, those in **Figs. G12** and **G13** are more obscure.

The engines in **Figs. G12** and **G13** appear to be imagined fixed-weight trebuchets designed to thrown bolts, perhaps similar to the trebuchet in **Fig. F31**. However, neither engine appears to have an axle and each has some kind of a platform on top of the framework – that in **Fig. G12** appears to be crenelated. The degree of confusion increases when considering that certain component labels refer to the use of hair, suggesting that these were supposed to be quasi-torsion engines.[1129]

A rare example of a counterweight trebuchet being mounted on top of a tower can be found in **Fig. G14**. The presence of a traction engine and what might be a machine similar to those in **Figs. G12** and **G13** flanking the counterweight trebuchet suggest, however, that this is more a creative exercise than an accurate portrayal of how such an engine might have been practically employed.[1130] A more accurate depiction of a siege scenario can be found in **Fig. G15**, featuring a single defensive traction trebuchet and a siege ladder.

[1129] This has led Cheveden to conclude that the each image instead depicts a *ziyar* – a partly torsion-powered bolt-throwing engine, Chevedden, "Black Camels," pp. 237-38.

[1130] Chevedden calls the left engine in **Fig. I35** a *ziyar*, which he believes to have been a classical two-armed torsion catapult, Chevedden, "Black Camels," p. 237 n. 21. Ibn al-Athir mentions the use of such engines by al-Zahir Ghazi at Saone in 1188, Ibn al-Athir, *al-Kamil*, trans. Richards, 2: 347-48.

Revisiting the Terminology

Al-Zardkash, like al-Tarsusi at least two centuries earlier, clearly named the engines that he included in his work. This is significant when considering that earlier sources employed similar terms when identifying engines used during the Frankish period. The traction trebuchet in **Fig. G8** is of the *shaytani* (appearing sometimes as *sultani*) type,[1131] a label not found amongst those used by al-Tarsusi. While the particulars of al-Zardkash's illustration cannot be confirmed, narrative accounts of thirteenth-century sieges appear to confirm that this term corresponded with a light traction trebuchet. Whether or not this was a trebuchet with a pole-frame, as shown by al-Zardkash, cannot be confirmed.

Shaytani/Sultani[1132]

Year	Site	Engines	Source
1218	Damietta	multiple	Ibn al-Dawadari
1248-49	Homs	12	Ibn Wasil; al-Ansari
1285	Margat	4	Ibn 'Abd al-Zahir
1291	Acre	52	al-Jazari; al-'Ayni; al-Yunini; Ibn al-Furat

Al-Zardkash identifies the familiar trestle-framed trebuchet in **Fig. G10**, as a *manjaniq maghribi*. The sources most commonly mention these engines at sieges in the 1230s to 1260s, and the presence of only one at a number of sieges suggests that they were relatively exceptional. Chevedden, concluding that counterweight trebuchets were in use before the appearance of these new terms, suggests that a technological change accompanied the appearance of the *manjaniq maghribi* in the sources, postulating that this might correlate with the development of the hinged counterweight, supplementing previous fixed counterweights.[1133] This theory may have been inspired by a similar one put forward by Fino.[1134] Although a convenient explanation, it seems unlikely that the hinged counterweight developed so late when considering that al-Tarsusi's primitive design in the late twelfth-century made use of a hanging counterweight.[1135] Thorau has suggested that *maghribi* in this context might be understood as European, rather than

[1131] See Chevedden, *The Citadel of Damascus*, pp. 282-83 and ns. 65-71 (on pp. 313-14).
[1132] See Chevedden, *The Citadel of Damascus*, pp. 282-83.
[1133] Chevedden, "King James I," p. 317 and n. 10.
[1134] Fino, "Machines de jet médiévales," p. 32.
[1135] See **Fig. C1**.

'western Islamic' (or North African), and may refer to a particular design originally developed in Western Europe.[1136] How he sees this relating to the oft-mentioned *manjaniq ifranji* is unclear.

Maghribi/Gharbi[1137]

Year	Site	Engines	Source
1218	Damietta	multiple	Ibn al-Dawadari
1232-33	Shayzar	1	Ibn Wasil; Ibn al-'Adim
1236	Harran	1	Ibn al-Muqaffa
1236	Edessa	1	Ibn al-Muqaffa
1248-49	Homs	1 of 14	Ibn Wasil; al-Ansari
1265	Caesarea	multiple	Ibn 'Abd al-Zahir; Ibn al-Furat
1266	Safed	multiple	Ibn 'Abd al-Zahir; Ibn al-Furat

Al-Zardkash calls the counterweight trebuchet with a forked short arm, seen in **Fig. G9**, a *manjaniq ifranji*. This type of engine is comparable to the European *bricola*, featured in **Figs. F18-F20**, **F24**, **F26** and **F29**. When the *manjaniq ifranji* is distinguished in accounts of siege during the late thirteenth century, however, it is described as being the heaviest or most powerful type of artillery. This is not at all an accurate portrayal of the type of engine presented by al-Zardkash, which necessarily sacrifices power for field of fire – the strength of a more complex framework is exchanged for the ability to yaw.

Accepting al-Zardkash's identification of the *manjaniq ifranji* as a trebuchet with a pole-frame and searching for the early use of such an engine in Europe, given its designation as 'Frankish', Chevedden has concluded that the first discernible use of such an engine dates to the Norman siege of Thessalonica in 1185. His argument rests on the account of Eustathius, which states that the engines that besieged the city from the west were of a new form.[1138] Concluding that the small and large engines of a 'traditional' type that besieged the city from the east were traction and counterweight trebuchets respectively, he asserts, almost arbitrarily, that the new engines to the west were a type of *bricola*. By identifying this as the earliest known reference to a *bricola*, a term which comes into use in the thirteenth century, Chevedden is able to suggest that this type of engine was developed in Europe in the late twelfth century and can be equated with the

[1136] Thorau, *The Lion of Egypt*, p. 160 n. 4 (on p. 179).
[1137] Chevedden, "Invention," p. 106 n. 137; Chevedden, *The Citadel of Damascus*, p. 280 and ns. 38-45 (on pp. 303-4).
[1138] See Eustathius, *Capture of Thessalonica*, trans. Melville Jones, pp. 92-105. Cf. Niketas Choniates, *Historia*, trans. Magoulias, pp. 164-65.

manjaniq ifranji when it appears in Muslim sources describing events of the thirteenth century.[1139]

Contrary to Chevedden's theory, the only description of these 'new' engines provided by Eustathius is that they were cumbersome and ineffective.[1140] These might have been early efforts to construct sizable counterweight trebuchets, as it is hard to qualify the necessarily light *bricola* as cumbersome. The larger of the 'traditional' engines to the east could have been early counterweight trebuchets or even sizable traction trebuchets. The *bricola* was the counterweight variety of the pole trebuchet. Its single vertical support allowed the engine to yaw but this freedom of movement came by sacrificing structural stability – all of the stresses incurred during the firing sequence were placed on the single support. Accordingly, it was not able to withstand as much strain or transfer as much energy as could a trestle-framed engine of comparable size. This makes it completely inappropriate to appear as the heaviest type of thirteenth-century Muslim artillery.

It is significant that references to the *manjaniq maghribi* decline with the appearance of the *manjaniq ifranji*. As both appear to refer to the heaviest stone-throwing engines of the day, it is possible that the two terms refer to the same, or very similar, type of engine: *maghribi* ('western') being replaced with *ifranji* ('Frankish') during the 1260s and 1270s. When found together, albeit infrequently, it is hard to distinguish the differences between them, as at Caesarea in 1265. In this sense, there may have been a terminological change but not necessarily a technological one; perhaps the increasing scale of these engines was judged sufficient to warrant a new term while the latter faded from use as counterweight trebuchets grew increasingly larger.

Writing in the late fourteenth or fifteenth-century, al-Zardkash may have used terms that were appropriate to the engines of his own day or, requiring two terms for two types of counterweight trebuchet, may even have arbitrarily assigned *maghribi* and *ifranji* without understanding what distinguished the two terms in the thirteenth century. It is perhaps noteworthy that Muslim sources rarely mention Frankish forces making use of a

[1139] Chevedden, "King James I," p. 318.

[1140] Chevedden, "Invention," pp. 94-95, 109. For a more general argument for the equation of *helepolis* with a heavy Byzantine stone-thrower, rather than a siege tower, as the term was used to designate during the classical period, see Dennis, "Byzantine Heavy Artillery," pp. 99-115. For a brief introduction to the classical *helepolis*, see Campbell, *Greek and Roman Siege Machinery*, pp. 5-13.

manjaniq ifranji, although there are few instances when Latin forces would have had the chance to use such an engine after the vocabulary emerged.

Ifranji/Firanji[1141]

Year	Site	Engines	Source
1265	Caesarea	multiple	Ibn 'Abd al-Zahir; Ibn al-Furat
1275	al-Bira	23 of 70	Ibn Shaddad; al-Yunini; Shafi' ibn 'Ali
1285	Margat	3 of 10	Ibn 'Abd al-Zahir
1286	Saone	4	Ibn 'Abd al-Zahir
1289	Tripoli	6 of 19	Ibn al-Dawadari; al-Yunini; Ibn al-Furat
1291	Acre	15 of 72	al-Jazari; al-'Ayni; al-Yunini; Ibn al-Furat

Al-Zardkash's treatment of the *manjaniq qarabughra*/*qarabugha* (the 'black camel' or 'black bull' trebuchet)[1142] is peculiar. While he might have associated this term with the bolt-throwing engines in **Figs. G12** and **G13**, he may also have intended it to refer to something quite different. Despite being unable to find any contemporary evidence to suggest that the *manjaniq qarabugha* was a bolt-throwing engine in the thirteenth century, Chevedden has suggested not only that the term referred to a bolt-throwing engine of the period, but also that it was transmitted from the Muslim world to Europe around this time.[1143]

References to bolt-throwing trebuchets are rare and the physics involved render the practical use of such an engine questionable. It is hard to imagine a swing-beam engine capable of producing a release velocity high enough to warrant its use to throw bolts. If such an engine could, presumably it would be more effectively employed throwing much larger stone projectiles at a lower velocity, which would transfer energy to the projectile much more efficiently. The natural strength of the counterweight trebuchet is its ability to transfer the potential energy within a suspended counterweight to a relatively heavy projectile. Once up to speed, the mass of these projectiles makes them less susceptible to drag, which would otherwise significantly inhibit the range of a lighter arrow thrown in this way. Although a heavy arrow, perhaps one filled with incendiaries, could hypothetically be thrown along a parabolic path, there would appear to be few incentives to throw an arrow rather than a sphere, as seen in **Figs. G1** and **G2**. Spheres are easier to produce and, given the necessary mass involved, lose little

[1141] See Chevedden, *The Citadel of Damascus*, pp. 281-82; Chevedden, "Invention," p. 107 n. 9.
[1142] The translation of this term comes from Chevedden, "Black Camels," p. 235 n. 12.
[1143] See Chevedden, "Black Camels," pp. 227-77, esp. pp. 259-60.

comparable velocity through flight despite being less aerodynamic. Furthermore, throwing an arrow would require a unique type of sling rigging to balance the weight of the projectile and ensure that it was released along a vector aligning with the arrow's long axis. When considering that arrows are most effective when they are light, thrown along a relatively level trajectory and at a reasonably high rate of fire, it seems unlikely that a bolt-throwing trebuchet was ever practically employed. Illustrations of such engines should perhaps be viewed as little more than theoretical exercises. This appears to be the case with **Fig. F31**, drawn by a roughly contemporary European artist.[1144]

When examined more closely, al-Zardkash does not appear to associate the *manjaniq qarabugha* with the illustrations of bolt-throwing engines. Instead, he includes the term at the end of a list of engines, perhaps intending the term to encompass all types of trebuchets. When examining the sources, the *manjaniq qarabugha* is portrayed as a relatively light stone-throwing engine, similar to, and frequently mentioned alongside, the *manjaniq shaytani*. It is unclear what differentiated the *manjaniq qarabugha* from the *manjaniq shaytani*, but both were almost certainly traction trebuchets.[1145]

Qarabughra/Qarabugha[1146]

Year	Site	Engines	Source
1248-49	Homs	1	Ibn Wasil
1285	Margat	3 of 10	Ibn 'Abd al-Zahir
1289	Tripoli	13 of 19	Ibn al-Dawadari; al-Yunini; Ibn al-Furat
1291	Acre	multiple	al-Jazari; al-'Ayni; al-Yunini; Ibn al-Furat

Modern Representations and Torsion Engines

Modern interpretations of trebuchets have been considerably influenced by those of certain Renaissance figures. Louis-Napoleon used a variety of Renaissance drawings, adapted from works such as those by Roberto Valturio and Paolo Santini, to illustrate

[1144] For additional European examples, all of which date to the Renaissance period, see Mariano di Jacopo Taccola, *De ingeneis*, liber secundus (c. 1420-50), f. 68v; Francesco di Giorgio Martini, *Opusculum de architectura* (c. 1470-75), f. 40r; Francesco di Giorgio, *Codicetto* (c. 1470–99), f. 99v. See also Chevedden, "Black Camels," pp. 239-42.
[1145] See Khamisy and Fulton,
[1146] See Chevedden, "Black Camels," p. 247.

what he believed to be various types of medieval artillery in **Fig. H1**. A step forward was taken by Viollet-le-Duc. As a military man and architect, he injected practicality and precision into his drawings and **Figs. H3** and **H4** have formed the basis of most 'historically accurate' reconstructed counterweight trebuchets. The footprint of these engines is derived from Honnecourt's plan but the superstructure is a conglomeration of inspiration from Renaissance examples and original imagination. His guesswork is revealed in **Fig. H2**: the counterweight, treadwheels and triggerman confirm that this is a counterweight engine, but a pulling team has been added to provide extra traction power. In reality, the efforts of the sixteen pullers would have added little force given the size of the counterweight and apparent necessity of treadwheels to lift it.

Unlike images of swing-beam engines, there are very few surviving medieval illustrations of torsion engines. **Fig. H5** is one such drawing. The clear inaccuracies reveal that the illustrator was unfamiliar with this type of engine. It appears to be an interpretation of a one-armed torsion engine, which the illustrator might have read about in certain classical texts. Although the coil, which provides resistance, is shown and the projectile is held in a cup, the beam seems better suited to a swing-beam engine and the second, superfluous coil, looks like the axle of a trebuchet. It is less clear what type of engine is meant to be depicted in **Fig. H6**. Illustrations such as these serve as a reminder that monks, most of whom lived sequestered lives in monasteries, were responsible for composing the vast majority of surviving images of medieval artillery. Many of these men may never have seen a trebuchet. In lieu of personal experience, they would have looked to classical texts, which may have influenced their illustrations as they did their vocabulary. Muslim artists of the thirteenth and fourteenth centuries tended to be slightly more worldly. They travelled and interact with different social groups to a greater degree than did their European counterparts and often held administrative posts. This greater degree of exposure probably contributed to the greater accuracy of their illustrations.

The illustrative evidence confirms many of the trends that have been discerned in the textual evidence, including the continued use of light traction engines as well as the development of increasingly heavy counterweight engines. For all that it reveals, the illustrative evidence contributes little to explaining why it took so long for the counterweight trebuchet to develop. Trebuchet technology was born out of the simplistic lever. Literary evidence suggests that traction engines reached Europe and the Near East during the Early Middle Ages and the use of such in Transoxiana is confirmed by **Fig. B1**. But even before this, the ancient *shaduf* had been employed for millennia to draw water from the Nile and the same principle is evident in Vegetius's *tollenno*. Although no counterweight trebuchets are featured in the Morgan Bible, the ominous machines used to hang bodies over the walls demonstrate an understanding of leverage and mechanical advantage.[1147] Thus the illustrative evidence is hard to sum up: certain examples provide *termini ad quem* for various technological innovations but it is hard to gain an accurate sense of scale given the range of images and their content. Accordingly, the illustrative material should be regarded as just one of many facets that helps us understand these machines and their development. On their own, these images can be misleading, but when incorporated with textual and archaeological evidence, and a sounds sense of the physics and mechanics involve, they can add to our appreciation of these engines and their development.

[1147] See Chapter 2 for these illustrations.

Fig. A1 c. 1200, Norman Italy: Peter of Eboli, *Liber ad honorem Augusti* (Bern, Burgerbibliothek, MS Cod. 120 II), f. 132r.

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Fig. A2 c. 1250-54, Acre: *Arsenal Bible* - David defeats Goliath (1 Kings 17:49) (Paris, Bibliothèque de l'Arsenal, MS 5211), f. 120r.

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Fig. A3 c. 1050-99, Catalonia: *Biblia Sancto Petri Rodensis* (*Roda Bible*) - expedition of Holofernes (Paris, BNF, MS lat. 6), f. 134r.

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Fig. A4 c. 1196, Norman Italy: Peter of Eboli, *Liber ad honorem Augusti* - defence of Salerno (Bern, Burgerbibliothek, BBB Cod. 120.II), f. 111r.

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Fig. A5 c. 1250, England: Matthew Paris, *Chronica Maiora* - siege of Damietta (Cambridge, Corpus Christi College Lib., MS 16, pt. 2), f. 59v.

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Fig. A6 c. 1250, England: Matthew Paris, *Chronica Maiora* - battle of Sandwich (Cambridge, Corpus Christi College Lib., MS 16, pt. 2), f. 56r.

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Fig. B1 c. 700-99, Piandijikent: Wall-painting from Piandijikent (St Petersburg, Hermitage) - taken from Nicolle, *Arms and Armour*, no. 24, 2:8.

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Fig. B2 c. 1100-25, Catalonia: Beatus of Liébana, *Commentary on the Apocalypse* - Nebuchadnezzar's siege of Jerusalem (Turin, Biblioteca Nazionale Universitaria di Torino, MS I.II.1), f. 109r.

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Fig. B4 c. 1196, Norman Italy: Peter of Eboli, *Liber ad honorem Augusti* - defence of Salerno (Bern, Burgerbibliothek, BBB Cod. 120.II), f. 111r.

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Fig. B5 c. 1196, Norman Italy: Peter of Eboli, *Liber ad honorem Augusti* (Bern, Burgerbibliothek, BBB Cod. 120.II), f. 132r.

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Fig. B6 c. 1196, Norman Italy: Peter of Eboli, *Liber ad honorem Augusti* - imprisonment of Roger of Andria (Bern, Burgerbibliothek, BBB Cod. 120.II), f. 104r.

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Fig. B7 c. 1196, Norman Italy: Peter of Eboli, *Liber ad honorem Augusti* - walls of Palermo (Bern, Burgerbibliothek, BBB Cod. 120.II), f. 97r - taken from Kölzer and Stähli, *Liber ad honorem Augusti*, p. 43.

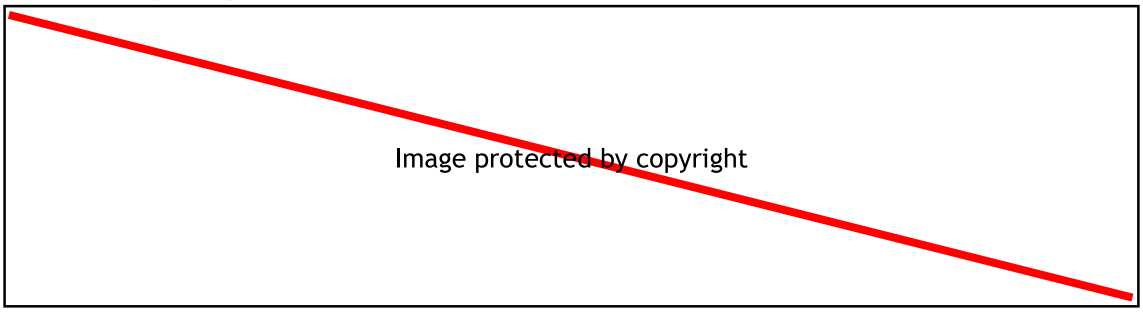

Fig. B8 c. 1196, Norman Italy: Peter of Eboli, *Liber ad honorem Augusti* (Bern, Burgerbibliothek, BBB Cod. 120.II), f. 96r - taken from Kölzer and Stähli, *Liber ad honorem Augusti*, p. 39.

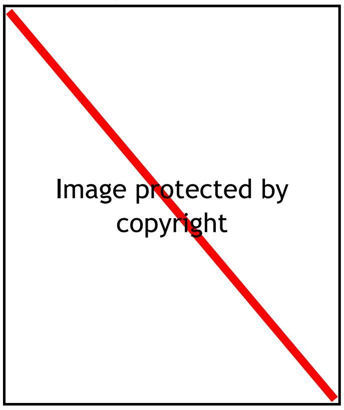

Fig. B9 c. 1196, Norman Italy: Peter of Eboli, *Liber ad honorem Augusti* - castrum maris, Palermo (Bern, Burgerbibliothek, BBB Cod. 120.II), f. 98r - taken from Kölzer and Stähli, *Liber ad honorem Augusti*, p. 47.

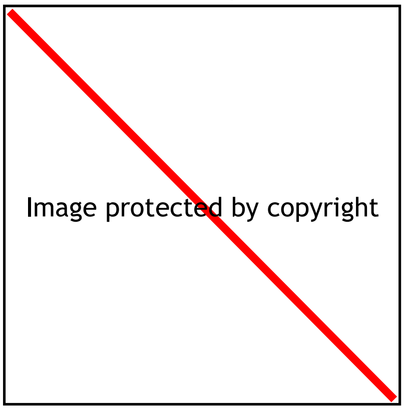

Fig. B10 c. 1196, Norman Italy: Peter of Eboli, *Liber ad honorem Augusti* - Monte Cassino (Bern, Burgerbibliothek, BBB Cod. 120.II), f. 108r - taken from Kölzer and Stähli, *Liber ad honorem Augusti*, p. 87.

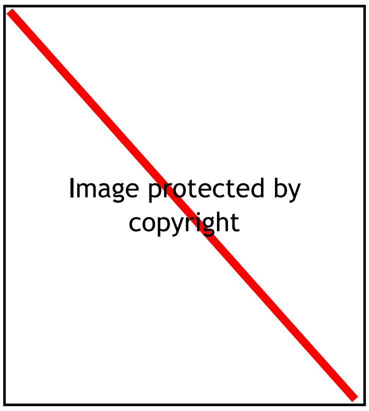

Fig. B11 c. 1196, Norman Italy: Peter of Eboli, *Liber ad honorem Augusti* (Bern, Burgerbibliothek, BBB Cod. 120.II), f. 114r - taken from Kölzer and Stähli, *Liber ad honorem Augusti*, p. 111.

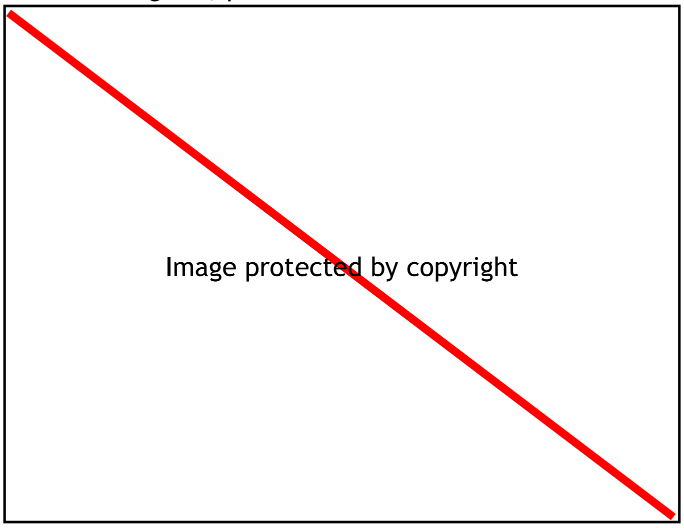

Fig. B12 12th-13th Cs, Sicily: *Skylitzes Chronicle* - siege of Mopsvestia (Madrid, Biblioteca Nacional de España, MSS Graecus Vitr. 26-2), f. 151r.

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Fig. B13 12th-13th Cs, Sicily: *Skylitzes Chronicle* - siege of Preslav (Madrid, Biblioteca Nacional de España, MSS Graecus Vitr. 26-2), f. 166r.

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Fig. B14 12th-13th Cs, Sicily: *Skylitzes Chronicle* - Battle of Dorustolon (Madrid, Biblioteca Nacional de España, MSS Graecus Vitr. 26-2), f. 169r.

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Fig. B15 c. 1220, Corneto: Graffito in Etruscan tomb. (Corneto-Tarquinia) - taken from Pringle, "A Medieval Graffito," p. 41, fig. 3.2.

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Fig. B16 c. 1220, south France: Tomb of Simon de Montfort (Carcassonne, Church of St Nazaire).

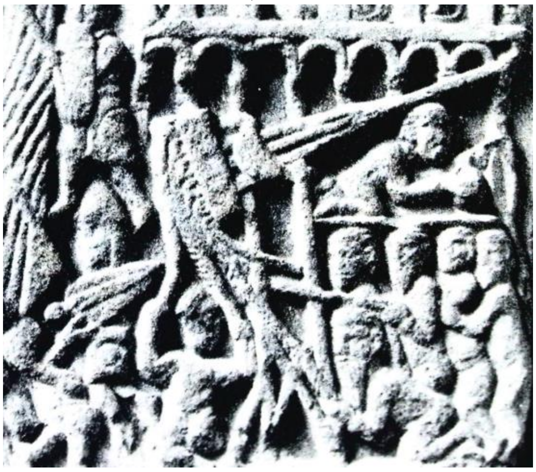

Fig. B17 c. 1225-50, France: *Oxford-Paris-London bible moralisée*, vol. 3a (London, BL, Harley 1526), f. 18v.

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Fig. B18 c. 1245-48, Paris: William of Tyre, *Histoire des Croisades* - siege of Nicaea (Paris, BNF, MS fr. 9081), f. 26r.

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Fig. B19 c. 1250, France: *Morgan Bible* - Saul's battle against the Ammonites (1 Kings 11:11) (New York, Pierpont Morgan Library, MS M.638), f. 23v.

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Fig. B20 c. 1250, France: *Morgan Bible* - siege of Able (2 Kings 20:15-22) (New York, Pierpont Morgan Library, MS M.638), f. 43v.

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Fig. B21 c. 1250, Genoa (?): Caffaro, *Annales de Genes* (Paris, BNF, MS lat. 10136), f. 107r.

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Fig. B22 c. 1250, Genoa (?): Caffaro, *Annales de Genes* - siege of Savona (Paris, BNF, MS lat. 10136), f. 141v.

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Fig. B23 c. 1250, England: Matthew Paris, *Chronica maiora* - agreement between the count of Brittany and al-Nasir of Kerak (Cambridge, Corpus Christi College Lib., MS 16, pt. 2), f. 139v.

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Fig. B24 c. 1260, c. 1280, Acre: William of Tyre, *Histoire de la guerre sainte* - siege of Tyre (Paris, BNF, MS fr. 2628), fol. 114r - taken from Buchthal, *Miniature Painting*, plate 132g.

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Fig. B25 c. 1278, Acre: William of Tyre, *History of Outremer*, vol. 1 - siege of Antioch (St. Petersburg, National Library of Russia, MS fr. f° v.IV.5, vol. 1), fol. 18v.

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Fig. B26 c. 1280, Acre: William of Tyre, *Les Estoires d'outremer* - siege of Antioch (Lyon, Bibliothèque Municipal, MS 828), f. 33r.

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Fig. B27 c. 1275-99, France: *Arthurian Romances* (Yale, Beinecke MS 229), f. 346r.

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Fig. B28 c. 1300-99, France (?): *Roman du Chevalier au Cygne et Chanson d'Antioch* (Paris, BNF, MS fr. 12558), f. 143v.

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Fig. B29 c. 1180, Egypt: Al-Tarsusi, *Tabsira arbab al-albab* - Frankish mangonel (Oxford, Bodleian Library, MS Hunt 264), f. 133r - taken from Chevedden, "Artillery of King James I," fig. 6.

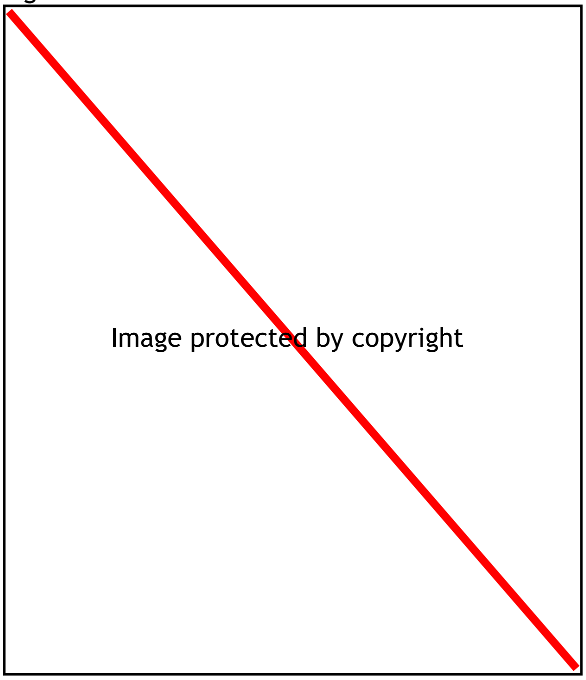

Fig. B30 c. 1180, Egypt: Al-Tarsusi, *Tabsira arbab al-albab* - Turkish mangonel (Oxford, Bodleian Library, MS Hunt 264), f. 138r - taken from Chevedden, "Artillery of King James I," fig. 5.

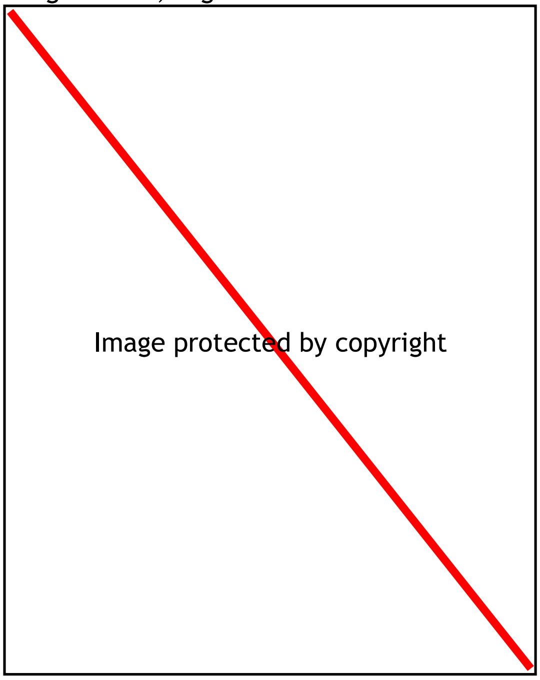

Fig. B31 c. 1180, Egypt: Al-Tarsusi, *Tabsira arbab al-albab* - Arab mangonel (Oxford, Bodleian Library, MS Hunt 264), f. 137r - taken from Chevedden, "Artillery of King James I," fig. 4.

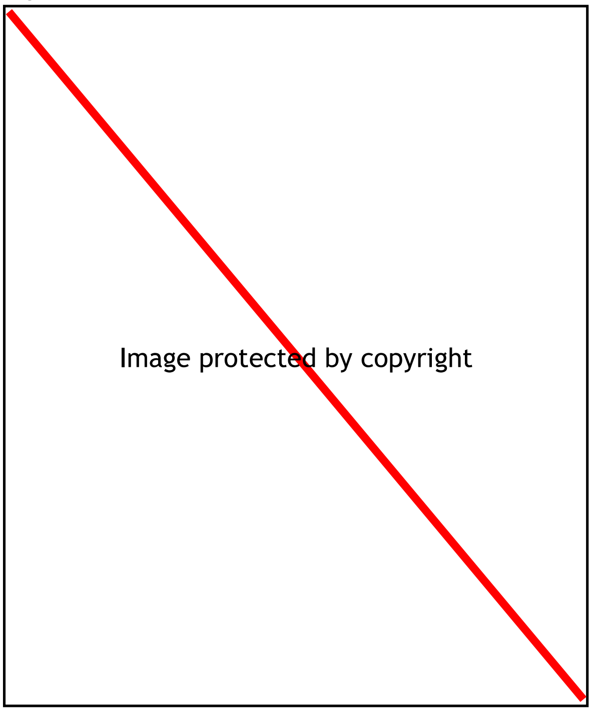

Fig. B32 c. 1250-96, Persia: Hasan al-Rammah, *Furusiya* (Paris, BNF, MS arabe. 2825), f. 88v.

Fig. B33 c. 1250-96, Persia: Hasan al-Rammah, *Furusiya* (Paris, BNF, MS arabe. 2825), f. 89r.

Fig. C1 c. 1180, Egypt: Al-Tarsusi, *Tabsirah arbab al-albab* - Persian mangonel (Oxford, Bodleian Library, MS Hunt. 264), ff. 134v-135r.

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Fig. C2 c. 1250, Genoa (?): Caffaro, *Annales de Genes* - siege of Savona (Paris, BNF, MS lat. 10136), f. 142r.

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Fig. C3 c. 1250, France (?): Villard of Honnecourt, *Sketch Book* - base of a trebuchet (Paris, BNF, MS fr. 19093), f. 30r, and facsimile copy from Lassus, Album, pl. 58.

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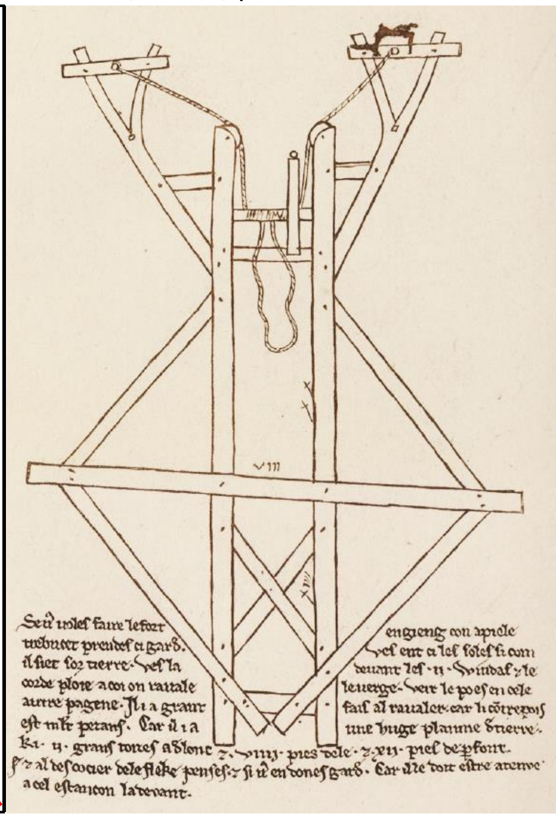

Fig. C4 c. 1200-99, France (?): *Chevalier au Cygne* (Paris, BNF, MS fr. 795), f. 220r.

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Fig. C5 c. 1275-99, France: *Roman de Renart* (Roman de la Rose) (Paris, BNF, MS fr. 1581), f. 8v.

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Fig. C6 c. 1300, Maastricht: *Book of Hours* (London, BL, Stowe MS 17), f. 243v.

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Fig. C7 c. 1280, Castile: *Cantigas de Santa Maria* (Florence, Biblioteca Nazionale, MS Banco Rari 20), f. 8r - taken from Chevedden, "Artillery of King James I," fig. 13.

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Fig. C8 c. 1291, Acre: William of Tyre, *History of Outremer* - siege of Antioch (Florence, Biblioteca Medicea-Laurenziana, MS Plu. LXI.10), f. 42r.

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Fig. C9 c. 1305, Flanders: Courtrai Chest - defeat of the French in 1302 (Oxford, New College).

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Fig. C10 c. 1316, England: Charter to Carlisle by Edward II - siege of Carlisle (Carlisle, Cumbria Records Office) - taken from Goodall, *The English Castle*, p. 246, fig. 185.

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Fig. C11 c. 1320-40, Paris: *Bible Historiale Complétée* (The Haag, Koninklijke Bibliotheek, KB 71 A), f. 201v.

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Fig. C12 c. 1337, Paris: *Li rommans de Godefroy de Buillon* (Paris, BNF, MS fr. 22495), f. 9r.

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Fig. C13 c. 1337, Paris: *Li rommans de Godefroy de Buillon* - siege of Nicaea (Paris, BNF, MS fr. 22495), f. 30r.

Fig. C14 c. 1332-50, Paris: *Chroniques de France ou de St Denis* (London, BL, Royal 16 G VI), f. 345v.

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Fig. C15 c. 1332-50, Paris: *Chroniques de France ou de St Denis* - siege of La Rochelle (London, BL, Royal 16 G VI), f. 388r.

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Fig. C16 c. 1300-99: William of Tyre, *Les Estoires d'outremer* - siege of Jerusalem (Paris, BNF, MS fr. 352), f. 62r.

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Fig. C17 c. 1340-60, France: *Avis aus Roys* - Besieging fortifications (New York, Pierpont Morgan Library, MS M.456), f. 127r.

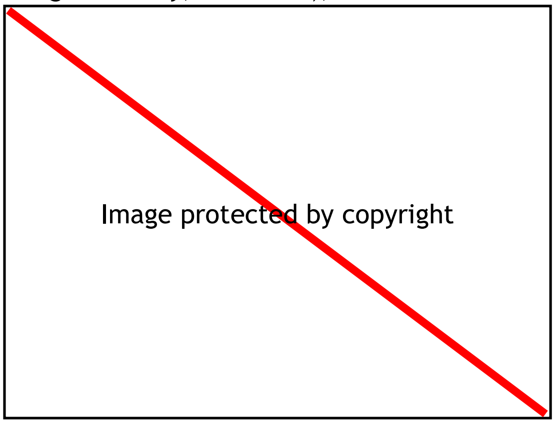


Fig. C18 c. 1340-60, France: *Avis aus Roys* - Defending against siege engines (New York, Pierpont Morgan Library, MS M.456), f. 131r.

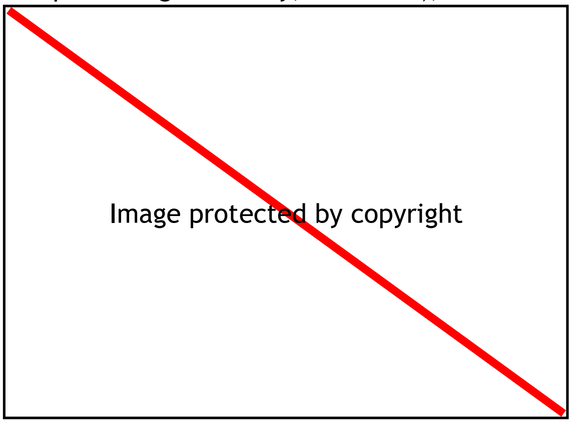


Fig. C19 c. 1270, Paris: William of Tyre, *Les Estoires d'Outremer* - siege of Nicaea (Paris, BNF, MS fr. 2630), f. 22v.

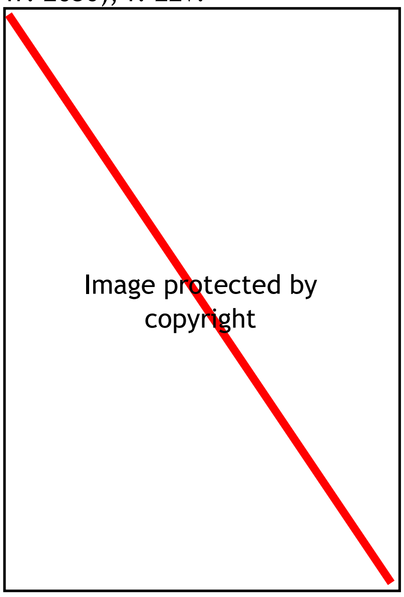
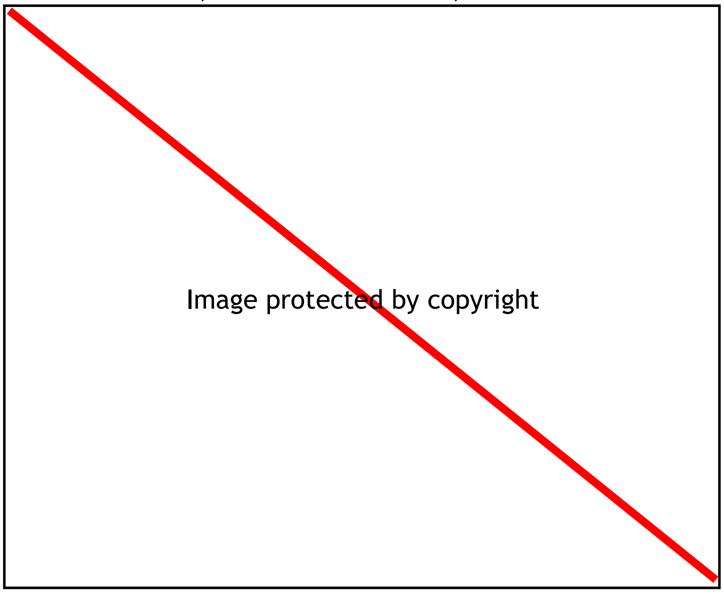
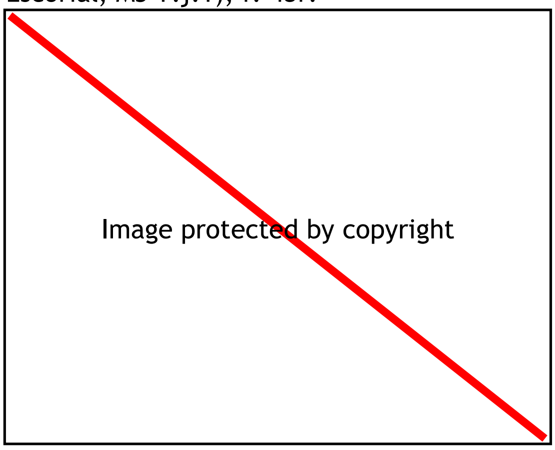


Fig. C20 c. 1270-75, Germany: Wolfram von Eschenbach, *Willehalm* (fragments) (Munich, Bayerische Staatsbibliothek, MS Cod. Ger. 193 III, f. 4v.



Figs. C21 and **C22** c. 1280, Castile: *Cantigas de Santa Maria* (Madrid: Biblioteca el Escorial, MS T.j.1), f. 43r.



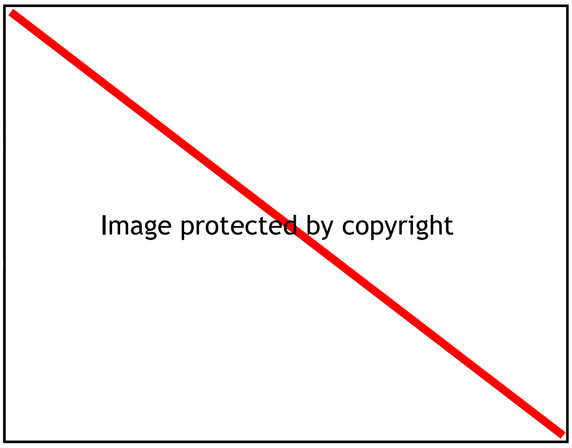


Fig. C23 c. 1308-12, London: *Roman de toute chevalière* (Paris, BNF, MS fr. 24364), f. 5v.

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Fig. D3 c. 1300, Paris: William of Tyre, *Histoire d'Outre Mer* - siege of Tyre (Baltimore, Walters Art Gallery, MS W.142), f. 112r.

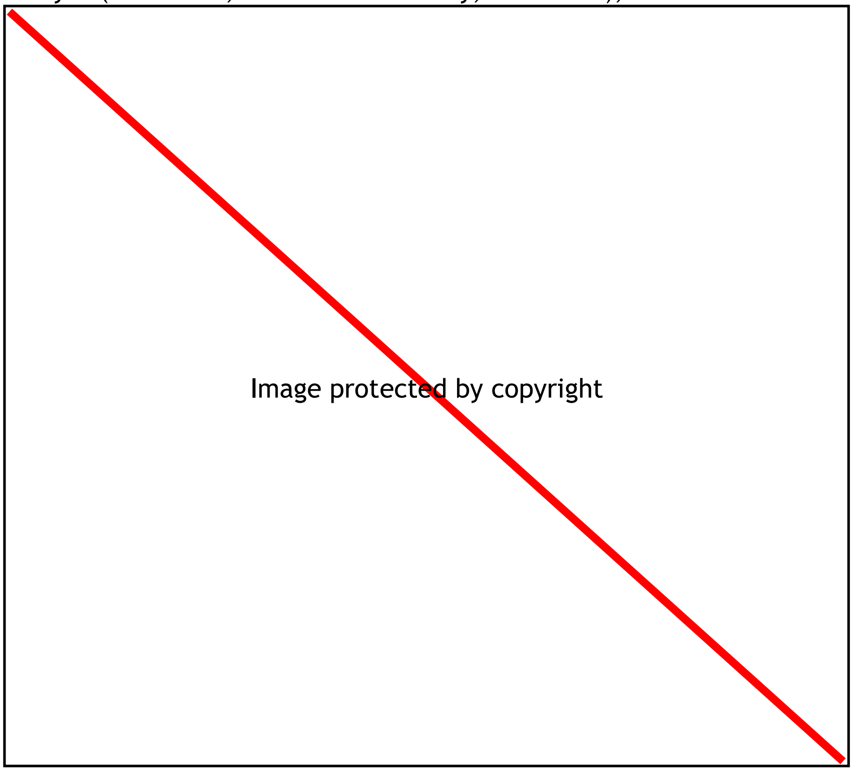

Fig. D4 c. 1300, Paris: William of Tyre, *Histoire d'Outre Mer* - siege of Antioch (Baltimore, Walters Art Gallery, MS W.142), f. 28r.

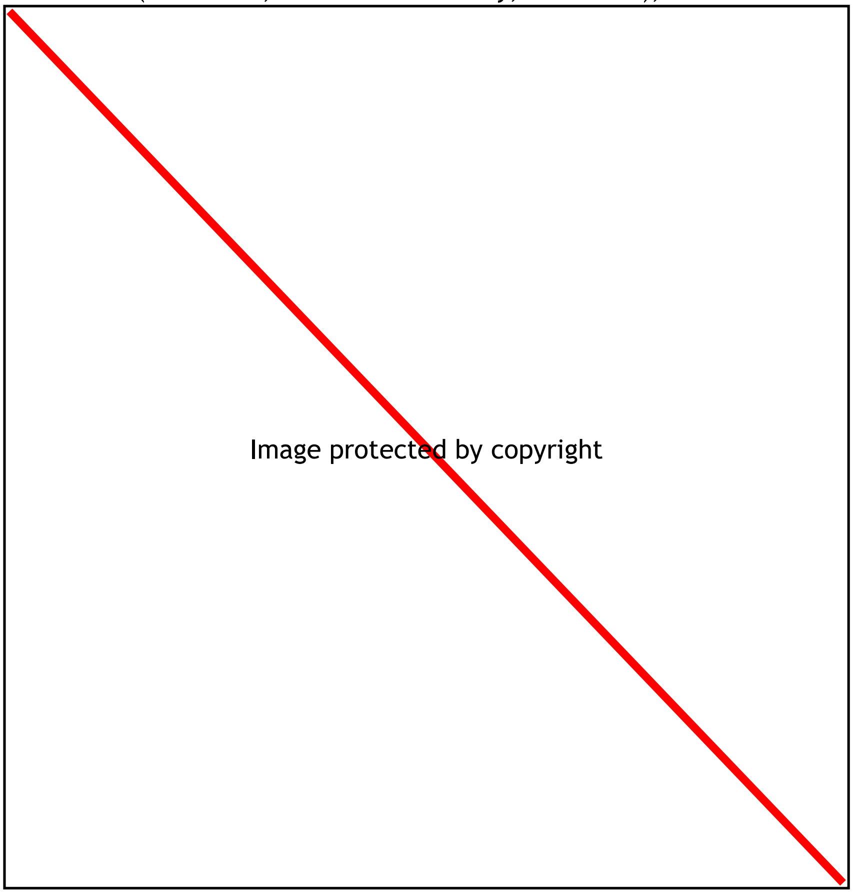

Fig. D5 c. 1300, France: William of Tyre, *Histoire de la guerre saint* - siege of Nicaea (Paris, BNF, MS fr. 2824), f. 15v.

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Fig. D6 c. 1300, France: William of Tyre, *Histoire de la guerre saint* - siege of Jerusalem (Paris, BNF, MS fr. 2824), f. 45r.

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Fig. D7 c. 1300, France: William of Tyre, *Histoire de la guerre saint* - siege of Shayzar (Paris, BNF, MS fr. 2824), f. 94v.

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Fig. E1 c. 1320, Siena: Simone Martini, *Guidoriccio da Fogliano* (Siena, Palazzo Pubblico).

Fig. E2 c. 1325-50, London (?): *Book of Hours* (*Neville of Hornby Hours*) - siege of Jerusalem (London, BL, MS Egerton 2781), f. 190v.

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Fig. F1 c. 1326, London: Walter of Milemete, *De nobilitatibus, sapientiis et prudentiis regum* (Oxford, Christ Church, MS 92), f. 67r.

Fig. F2 c. 1360, Regensburg: *Weltchronik* (New York, Pierpont Morgan Library, MS M.769), f. 193r.

Fig. F3 c. 1375-85, Swabia: *History Bible* - siege of Ai by Joshua (New York, Pierpont Morgan Library, MS M.268), f. 11v.

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Fig. F4 c. 1384-1400, Paris: *Fleurs des chroniques* (Besançon, Bibliothèque Municipale, MS 677), f. 45r.

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Fig. F5 c. 1368-1424, Lucca: *Croniche di Giovanni Sercambi* - siege of Nocera (Lucca, Archivio di Stato, MS 107), f. 113v.

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Fig. F6 c. 1435, Rottweil: *Ordnung des Hofgerichts zu Rottweil* - Lothar III besieges Conrad III (Stuttgart: Württembergische Landesbibliothek, HB VI 110), f. ir.

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Fig. F7 c. 1400, England: *Alexander and Dindimus* (Oxford, Bodleian Library, MS 264), f. 255r.

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Fig. F8 c. 1405, Germany: Konrad Kyeser, *Bellifortis* (Göttingen, Niedersächsische Staats- und Universitätsbibliothek, Cod. philos. 63), f. 30r.

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Fig. F9 German (?): Konrad Kyeser, *Bellifortis* (Innsbruck, Tiroler Landesmuseum Ferdinandeum, Cod. FB 32009 (olim 16.0.7), f. 21r.

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Fig. F10 c. 1405, Germany: Konrad Kyeser, *Bellifortis* (Munich, Bayerische Staatsbibliothek, Clm 30150), tafel 2, f. 2v.

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Fig. F11 c. 1459, Germany (?): Konrad Kyeser, *Bellifortis*, in Talhoffer, *Fechtuch* (Copenhagen, Det Kongelige Bibliotek, MS Thott. 290.2), f. 16v.

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Fig. F12 c. 1459, Germany (?): Konrad Kyeser, *Bellifortis*, in Talhoffer, *Fechtuch* (Copenhagen, Det Kongelige Bibliotek, MS Thott. 290.2), 32r.

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Fig. F13 c. 1459, Germany (?): Konrad Kyeser, *Bellifortis*, in Talhoffer, *Fechtuch* (Copenhagen, Det Kongelige Bibliotek, MS Thott. 290.2), 14v.

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Fig. F14 c. 1419-50, Italy: Mariano di Jacopo Taccola, *De ingeneis*, liber secundus (Munich, Bayerische Staatsbibliothek, Cod. lat. Monacensis 197), f. 40v.

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Fig. F15 c. 1474-82, Italy: Francesco di Giorgio, *Opusculum de architectura* (London, British Museum, Cod. 197.b.21 - MS Harley 3281), f. 3v.

Image protected by copyright

Fig. F16 c. 1419-49, Italy: Mariano di Jacopo Taccola, *De machinis* - trabocco, for throwing incendiaries (Paris, BNF, MS lat. 7239), f. 22v.

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Fig. F17 c. 1433, Italy: Mariano di Jacopo Taccola, *De ingeneis ac edifitiis non usitatis*, liber tertius - Manganum (Florence, Biblioteca Nazionale Centrale, Cod. Palatino 766), ff. 66v-67r - taken from Prager and Scaglia, *Mariano Taccola*, pl. 93, p. 142.

Fig. F18 c. 1433, Italy: Mariano di Jacopo Taccola, *De ingeneis ac edifitiis non usitatis*, liber tertius - Brichola (Florence, Biblioteca Nazionale Centrale, Cod. Palatino 766), ff. 67v-68r - taken from Prager and Scaglia, *Mariano Taccola*, pl. 95, p. 143.

Fig. F19 c. 1419-50, Italy: Mariano di Jacopo Taccola, *De ingeneis*, liber secundus (Munich, Bayerische Staatsbibliothek, Cod. lat. Monacensis 197), f. 39v.

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Fig. F20 Italy (?): Anonymous (Siena, Biblioteca Comunale, Cod. S.IV.5), f. 25r.

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Fig. F21 c. 1419-50, Italy: Mariano di Jacopo Taccola, *De ingeneis*, liber secundus (Munich, Bayerische Staatsbibliothek, Cod. lat. Monacensis 197), f. 95r.

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Fig. F22 Italy (?): Anonymous (Sienna, Biblioteca Comunale, Cod. S.IV.5), f. 57v.

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Fig. F23 c. 1463, Italy: Roberto Valturio, *De re militari libri duodecim* (Paris, BNF, MS lat. 7236), f. 148v.

Image protected by copyright

Fig. F24 c. 1463, Italy: Roberto Valturio, *De re militari libri duodecim* (Paris, BNF, MS lat. 7236), f. 149r.

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Fig. F25 c. 1463, Italy: Roberto Valturio, *De re militari libri duodecim* (Paris, BNF, MS lat. 7236), f. 149v.

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Fig. F26 c. 1463, Italy: Roberto Valturio, *De re militari libri duodecim* (Paris, BNF, MS lat. 7236), f. 150r.

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Fig. F27 c. 1470-75, Hungary (?): Paolo Santini, *Tractatus* (Paris, BNF, MS lat. 7239), f. 109r.

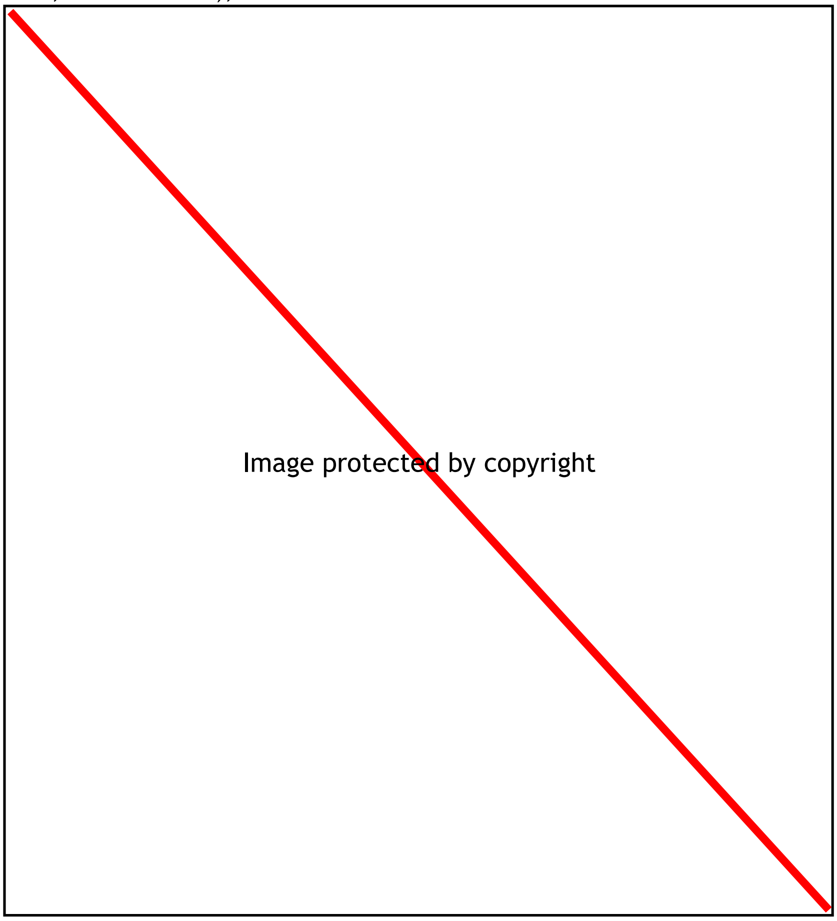

Fig. F28 c. 1480-99, Italy: Francesco di Giorgio, *Trattato* - trebuchet (Turin, Biblioteca Reale, Cod. 148 Saluzzo), f. 60r - taken from Corrado Maltese, ed., *Trattati*, tav. 111.

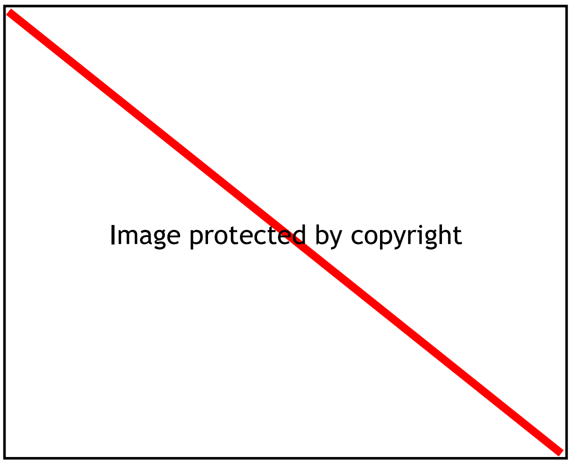

Fig. F29 c. 1480-99, Italy: Francesco di Giorgio, *Trattato* - bricola (Turin, Biblioteca Reale, Cod. 148 Saluzzo), f. 60r - taken from Corrado Maltese, ed., *Trattati*, tav. 111.

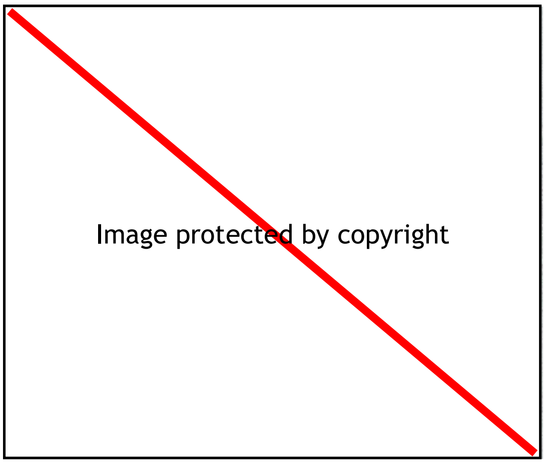

Fig. F30 c. 1480-99, Italy: Francesco di Giorgio, *Trattato* (Turin, Biblioteca Reale, Cod. 148 Saluzzo), f. 62r - taken from Corrado Maltese, ed., *Trattati*, tav. 115.

Fig. F31 c. 1480-99, Italy: Francesco di Giorgio, *Trattato* (Turin, Biblioteca Reale, Cod. 148 Saluzzo), f. 61v.

Fig. F32 c. 1478-1519, Italy: Leonardo da Vinci, *Codex Atlanticus* - rotary trebuchet (Milan, Biblioteca Ambrosiana), f. 57.

Fig. F33 c. 1478-1519, Italy: Leonardo da Vinci, *Codex Atlanticus* - tension catapult (Milan, Biblioteca Ambrosiana), f. 50v.

Fig. F34 c. 1507, Germany: Jörg Kölderer (woodcut).

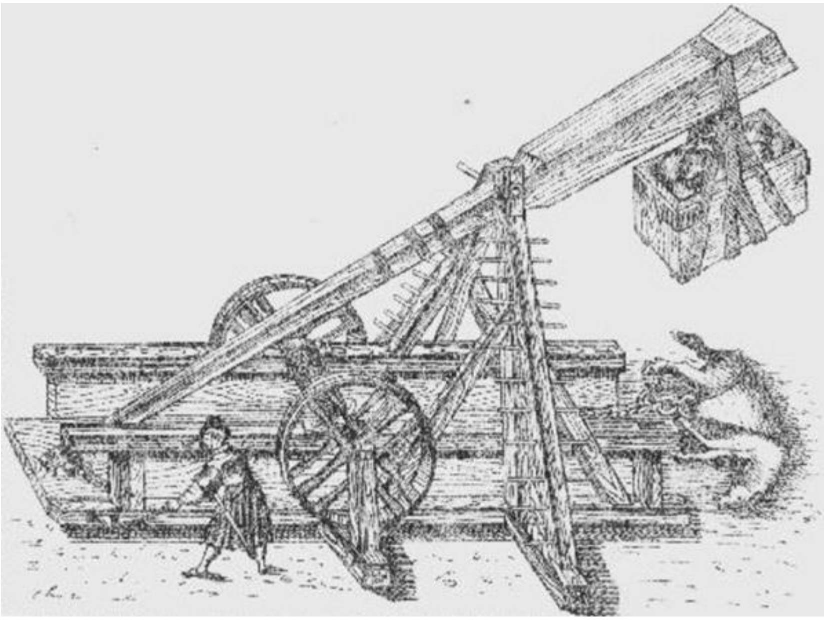

Fig. G1 c. 1285, Syria/Persia: Hasan al-Rammah, *Furusiya* (Paris, BNF, MS arabe. 2825), f. 87v.

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Fig. G2 c. 1285, Syria/Persia: Hasan al-Rammah, *Furusiya* (Paris, BNF, MS arabe. 2825), f. 90r.

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Fig. G3 c. 1306-18, Tabriz: Rashid al-Din, *Jami' al-tawarikh* (Edinburgh, University of Edinburgh Library, Or. MS 20), f. 130v.

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Fig. G4 c. 1306-18, Tabriz: Rashid al-Din, *Jami' al-tawarikh* (Edinburgh, University of Edinburgh Library, Or. MS 20), f. 124v.

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Fig. G5 c. 1306-18, Tabriz: Rashid al-Din, *Jami' al-tawarikh* (Edinburgh, University of Edinburgh Library, Or. MS 20), f. 3v.

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Fig. G6 c. 1306-18, Tabriz: Rashid al-Din, *Jami' al-tawarikh* - siege of Baghdad (Berlin, Staatsbibliothek, Orientabteilung, Diez A), f. 70, S. 7 and S. 4.

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Fig. G7 c. 1430, Herat: Rashid al-Din, *Jami' al-tawarikh* (Paris, BNF, MS pers. 1113), f. 180v-181r.

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Fig. G8 c. 1373-1462, Syria/Persia: Al-Zardkash, *Kitab al-Aniq fi'l-Manjaniq* - manjaniq sultano/shaytani (Istanbul, Topkapi Museum Library, MS Ahmad III 3469), f. 31r.

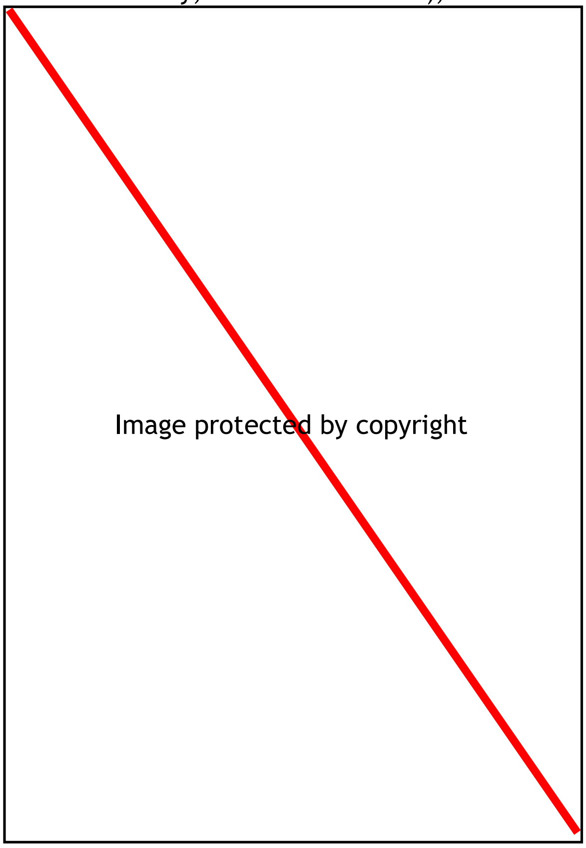

Fig. G9 c. 1373-1462, Syria/Persia: Al-Zardkash, *Kitab al-Aniq fi'l-Manjaniq* - manjaniq ifranji (Istanbul, Topkapi Museum Library, MS Ahmad III 3469), f. 20r.

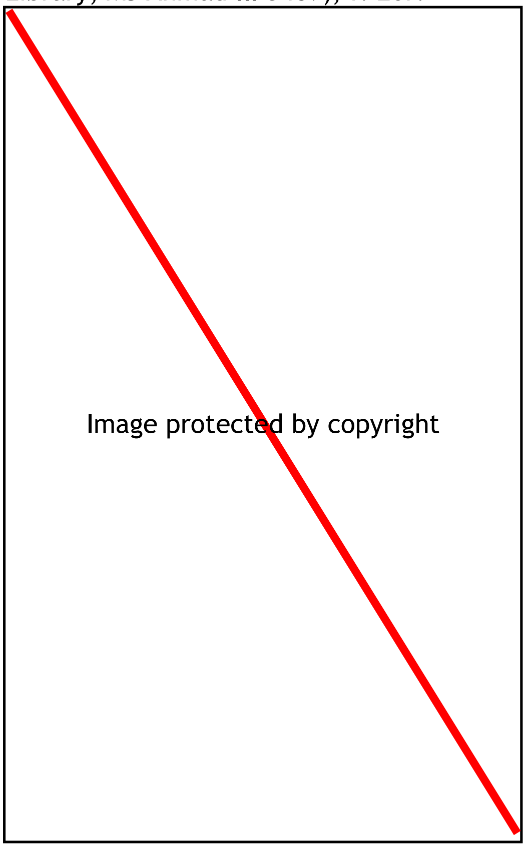

Fig. G10 c. 1373-1462, Syria/Persia: Al-Zardkash, *Kitab al-Aniq fi'l-Manjaniq* - manjaniq maghribi (Istanbul, Topkapi Museum Library, MS Ahmad III 3469), f. 30v.

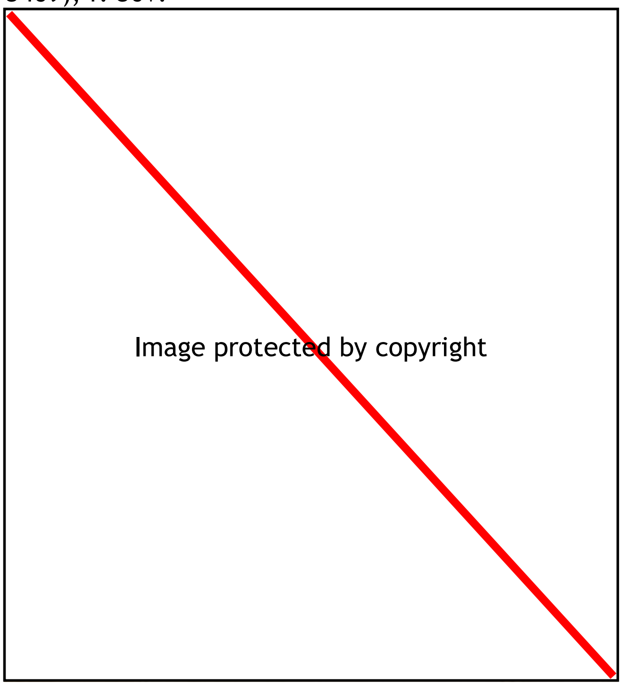

Fig. G11 c. 1373-1462, Syria/Persia: Al-Zardkash, *Kitab al-Aniq fi'l-Manjaniq* (Istanbul, Topkapi Museum Library, MS Ahmad III 3469), f. 25v.

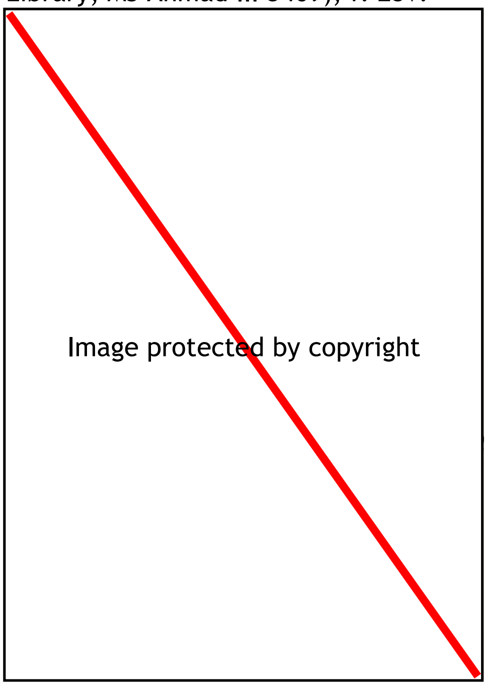

Fig. G12 c. 1373-1462, Syria/Persia: Al-Zardkash, *Kitab al-Aniq fi'l-Manjaniq* - manjaniq qarabughra (Istanbul, Topkapi Museum Library, MS Ahmad III 3469), f. 32r.

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Fig. G13 c. 1373-1462, Syria/Persia: Al-Zardkash, *Kitab al-Aniq fi'l-Manjaniq* (Istanbul, Topkapi Museum Library, MS Ahmad III 3469), f. 34r.

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Fig. G14 c. 1373-1462, Syria/Persia: Al-Zardkash, *Kitab al-Aniq fi'l-Manjaniq* (Istanbul, Topkapi Museum Library, MS Ahmad III 3469), f. 33r.

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Fig. G15 c. 1373-1462, Syria/Persia: Al-Zardkash, *Kitab al-Aniq fi'l-Manjaniq* (Istanbul, Topkapi Museum Library, MS Ahmad III 3469), f. 44r.

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Fig. H1 c. 1851, France: Louis Napoleon Bonaparte, *Études sur le passé et l'avenir de l'artillerie*, vol. 2, plate 1 (after p. 26).

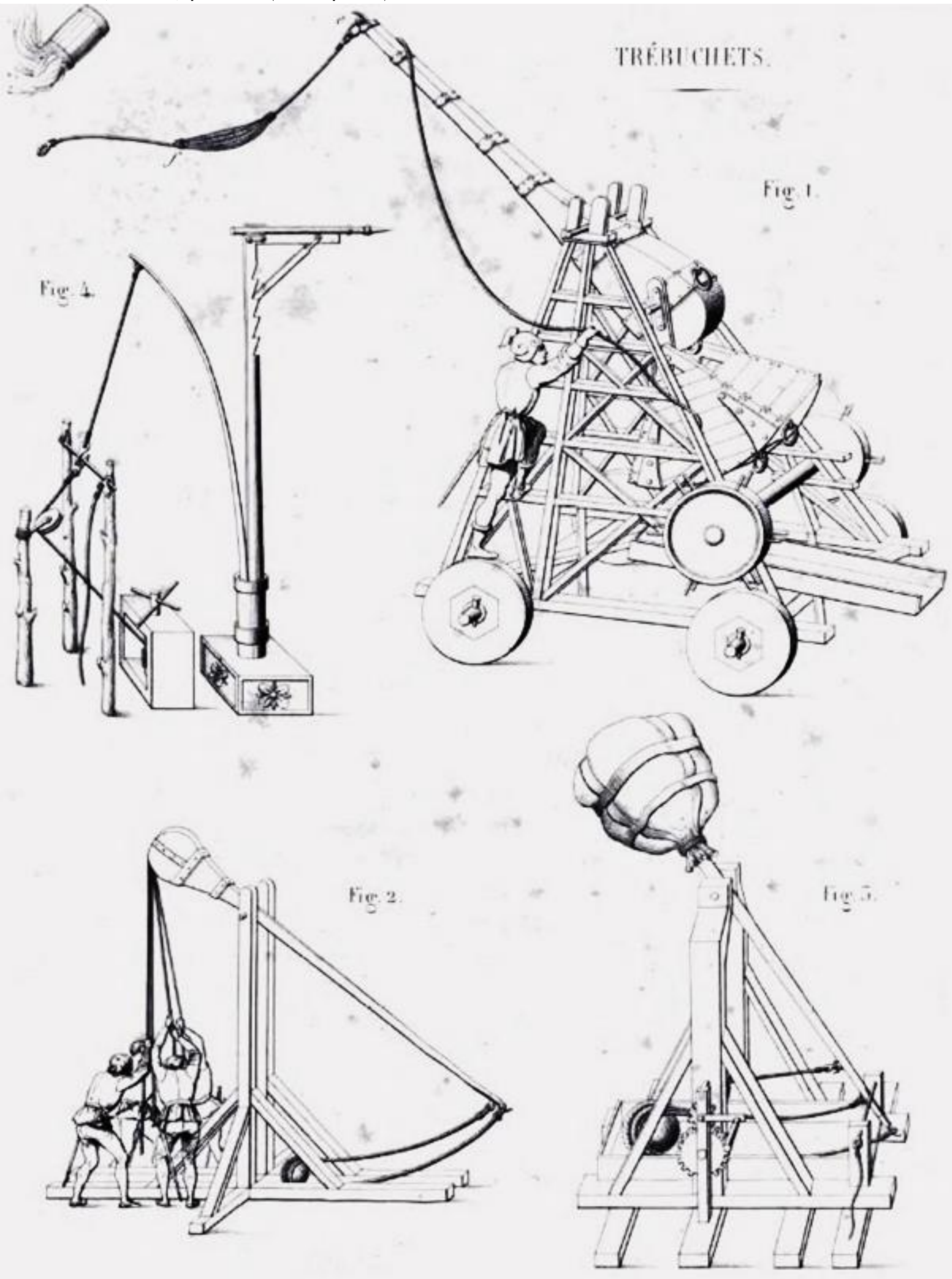


Fig. H2 c. 1860, France: Viollet-le-Duc, *Dictionnaire*, 5:237, fig. 14.

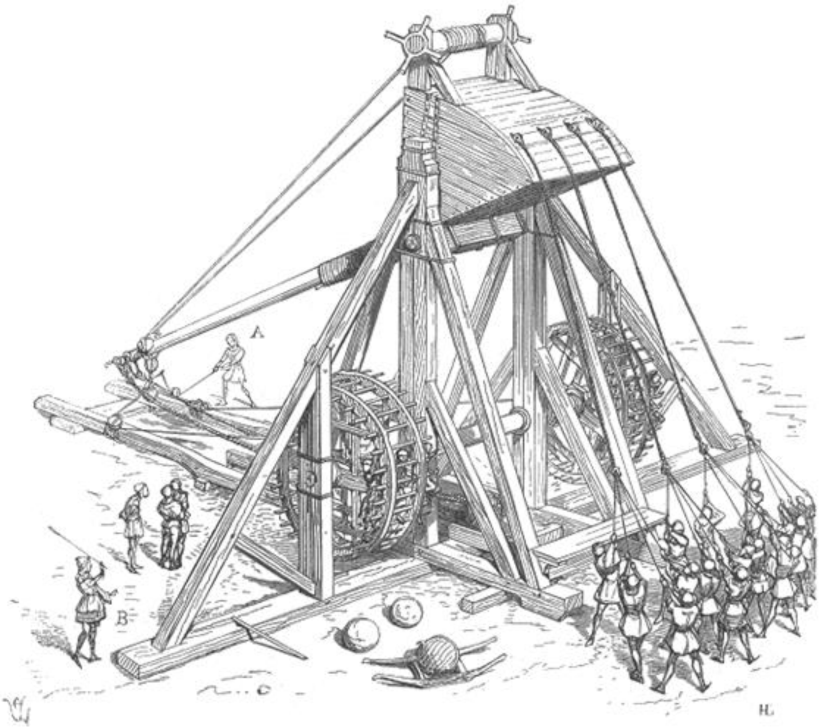


Fig. H3 c. 1860, France: Viollet-le-Duc, *Dictionnaire*, 5:227, fig. 9.

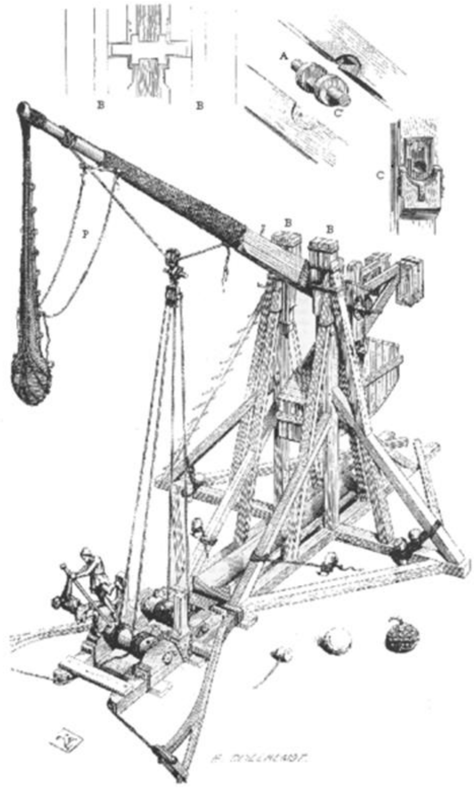


Fig. H4 c. 1860, France: Viollet-le-Duc, *Dictionnaire*, 5:228, fig. 10.

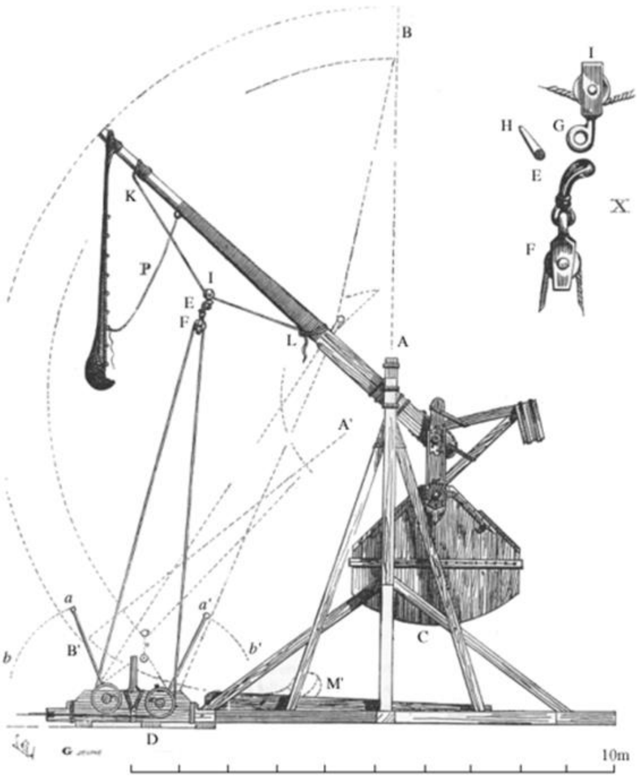


Fig. H5 c. 1326, London: Walter of Milemete, *De nobilitatibus, sapientiis et prudentiis regum* (Oxford, Christ Church College, MS 92), f. 78v.

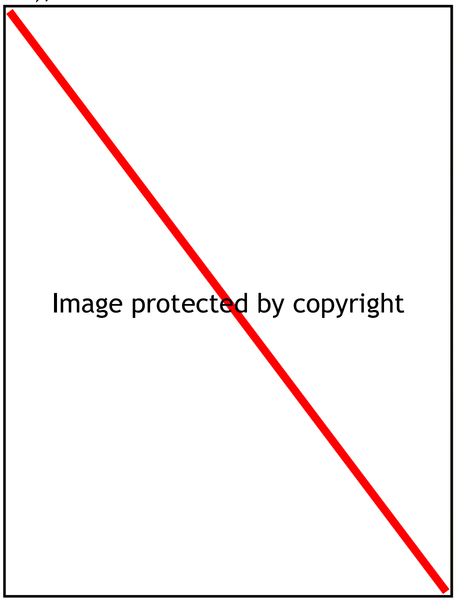


Fig. H6 c. 1340, Paris: *Historia de Proeliis* (La vraie ystoire dou bon roi Alixandre) - siege of Saianfu (London, BL, Royal D I), f. 111.

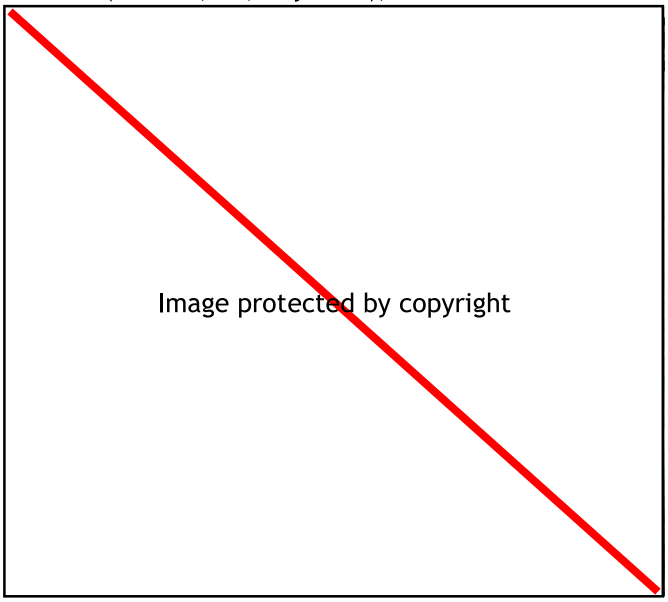


Fig. H7 c. 1801, England: Francis Grose, *Military Antiquities*, vol. 1, facing p. 381.

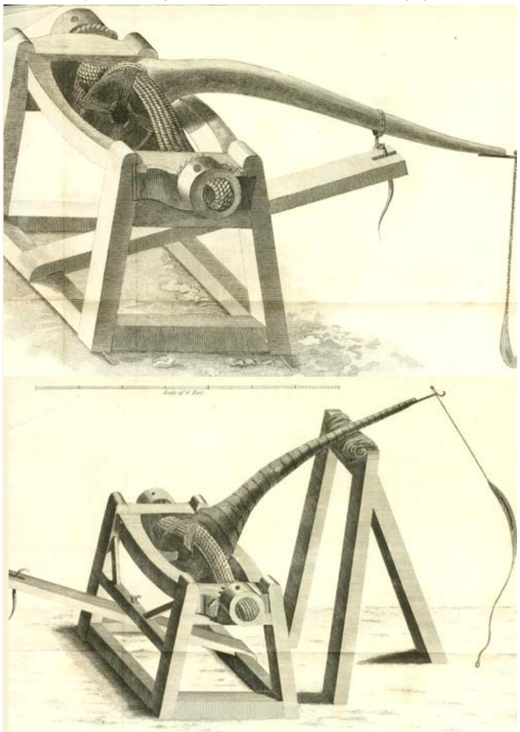
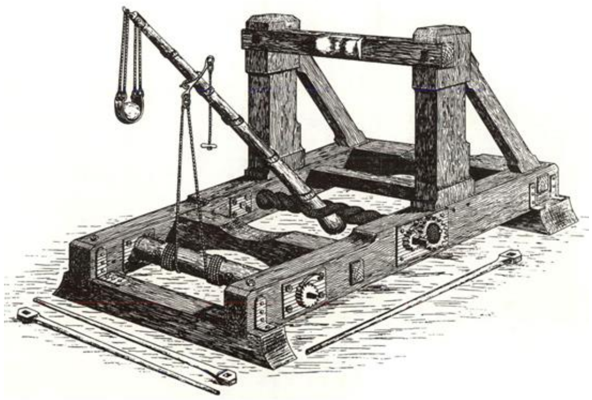


Fig. H8 c. 1903, England: Ralph Payne-Gallwey, *The Crossbow*, Appendix 1: The Catapult and the Balista, p. 10 fig. 1.



Appendix 2.
Mentions of Artillery

Artillery in Narrative Sources (1099-1250)[1148]

Date	Site & Use (Christian/Muslim)		Employer(s)	Source(s)
Fall of Jerusalem				
1099	Arsuf	offensive	Godfrey of Bouillon	AA
1100	Haifa	offensive	Tancred	AA
1101	Caesarea	offensive	Baldwin I	FC, AA, WT
1102	Acre	offensive	Raymond of St Gilles	IA
1103	Acre	offensive	Baldwin I	AA
1104	Acre	offensive	Baldwin I	FC, AA, WT
1106	Apamea	offensive	Tancred	AA
1106	Malatya	offensive	Kilij Arslan	MS, BH
1106/7	Arnaldi	offensive	Egyptians	AA
1108	Sidon	offensive	Baldwin I	AA
1109	Tripoli	offensive	Bertrand of Tripoli	AA, IQ
1110	Baalbek	offensive	Tughtakin	IQ
1110	Beirut	offensive	Baldwin I	AA, WT
		defensive	garrison	IQ
1110	Sidon	offensive	Baldwin I, Magnus of Norway	AA
		defensive	garrison	AA
1110	al-Atharib	offensive	Tancred	AA
1111	Vetula	offensive	Tancred	AA
1111-12	Tyre	offensive	Baldwin I	AA, IQ, IA
		defensive	garrison	AA
1115	Kafartab	defensive	garrison	US
1115	Jaffa	defensive	garrison	WT
1121	Jerash	offensive	Baldwin II	FC
1123	Kharput	offensive	Balak	ME, MS, AC, BH
1123	Jaffa	offensive	Egyptians	FC
1124	Tyre	offensive	Franks, Venetians	FC, ME, WT, AC

[1148] Chronicles and histories that span several decades have been selected, rather than more specific accounts, with hopes of revealing broader trends. Less specific Latin and Arabic references to 'machines' and 'siege engines' have been omitted unless these are explicitly described as throwing stones larger than those that a slinger might.

		defensive	garrison	WT
1124	Manbij	offensive	Balak	ME
1125	'Azaz	offensive	Bursuqi, Tughtakin	FC, ME, WT, AC
1126	Raffaniya	offensive	Baldwin II, Pons of Tripoli	FC, WT
1132	Baalbek	offensive	Tughtakin	IQ
1137	Antioch	offensive	John Comnenus	WT
1137	Montferrand	offensive	Zanki	WT
1138	Shayzar	offensive	John Comnenus	IQ, US, WT, IA, MS, BH, AF
1138	Buza'a	offensive	John Comnenus	IQ, IA
1139	Baalbek	offensive	Zanki	IQ, IA, AC, AF
1140	Banyas	offensive	Mu'in al-Din Unar, Franks	IQ, WT
1144	Li Vaux Moise	offensive	Baldwin III	WT
1144	Edessa	offensive	Zanki	IQ, WT, AC, BH
1145	al-Bira	offensive	Zanki	AC
1145	In Homs for Damascus	prepared	Zanki	IQ
1146	In Damascus for Baalbek	prepared	Mu'in al-Din Unar	IQ
1146	Edessa	offensive	Joscelyn of Courtenay	AC
1147	In Damascus for Sarkhad, Bosra	prepared	Mu'in al-Din Unar	IQ
1150/51	Tell Bashir	offensive	Mas'ud	ME
1151	Jerusalem	offensive	Baldwin III	WT
		defensive	Melisende (garrison)	WT
1151	In Damascus for Bosra	prepared	summoned by Nur al-Din	IQ
1152	In Damascus for Bosra	prepared	summoned by Mujir al-Din	IQ
1153	Ascalon	offensive	Baldwin III	WT, AC, BH
1157	In Damascus for Banyas	prepared	summoned by Nur al-Din	IQ
1157	Banyas	offensive	Nur al-Din	IQ, WT
1157	Shayzar	offensive	Baldwin III, Thierry of Flanders	WT
1157-58	Casalia*	offensive	Baldwin III, Thierry of Flanders	WT
1158	Harim	offensive	Baldwin III, Thierry of Flanders	IQ
1164	Harim	offensive	Nur al-Din	WT, IA, AC
1167	Alexandria	offensive	Amalric	WT
1169	Damietta	offensive	Amalric, Byzantines	WT, BD, MQ
1170	Kerak	offensive	Nur al-Din	ID, IA
1170	Sinjar	offensive	Nur al-Din	IA
1174	Alexandria	offensive	William II of Sicily	ID, BD, IA, MQ
1175	Homs	offensive	Saladin	MQ
1175	Montferrand	offensive	Saladin	IA
1175	Sinjar	offensive	Sayf al-Din Ghazi II	BD
1176	A'zaz	offensive	Saladin	IA
1176	Masyaf	offensive	Saladin	IA, MQ
1177-78	Harim	offensive	Philip of Flanders, North Franks	WT, IA, AC
1179	Jacob's Ford	offensive	Saladin	ID, IA
1182	In Egypt for Syria	prepared	Saladin	MQ
1183	Amid	offensive	Saladin	IA
1183	Tell Khalid	offensive	Saladin	IA
1183	Kerak	offensive	Saladin	WT, IA
1184	Kerak	offensive	Saladin	ID, BD, IA, BH, MQ
1185	Mayyafariqin	offensive	Saladin	BD, IA
Battle of Hattin				
1187	Toron	offensive	Saladin	ID, BD

1187	Ascalon	offensive	Saladin	ID, BD, IA, MQ
1187	Jerusalem	offensive	Saladin	ID, BD, IA, BH, MQ
		defensive	Balian of Ibelin (garrison)	IA
1187	Tyre	offensive	Saladin	ID, BD, IA, BH, MQ
1188	Saone	offensive	Saladin	ID, BD, IA
1188	Ash-Shughr	offensive	Saladin	ID, BD, IA
1188	Bourzey	offensive	Saladin	ID, BD, IA
		defensive	garrison	IA
1188	Trapessac	offensive	Saladin	ID, BD, IA
1188	Baghras	offensive	Saladin	ID, IA
1188	Safed	offensive	Saladin	ID, BD, IA
1188	Belvoir	offensive	Saladin	ID, IA
1190	Acre	offensive	Henry of Champagne	ID, BD, IA
		defensive	garrison	ID, IA
1190	Acre	defensive	garrison	ID, BD
1191	Acre	offensive	Richard I, Philip II, et al.	ID, BD, IA, MQ, BH
		defensive	garrison	BD
1192	Jaffa	offensive	Saladin	BD
1199	Montferrand	offensive	al-Mansur Nasir al-Din	AF
1207	Tripoli	offensive	al'Adil	AF
1217	Mount Tabor	offensive	Crsuaders	IA
1218	Tower of the Chain	offensive	Crusaders	ER
1218	Damietta	offensive	Crusaders	ER
1218	Damietta (in the field)	offensive	Crusaders	IA
1220	Caesarea	offensive	Mu'azzam Isa	ER
1221	Mansura (in the field)	offensive	Crusaders	IA, MQ
1229	Tell Khilid	offensive	Jalal al-Din Khwarizim	BH, MQ
1231-32	Beirut	offensive	Imperialists	ER
1232	Amid	offensive	al-Kamil	MQ
1239	Jerusalem	offensive	al-Nasir Da'ud	MQ
1245	Damascus	offensive	al-Nasir Da'ud	MQ
1247	Ascalon	offensive	Egyptians	ER
1248-49	Homs	offensive	al-Salih Najm	AF, MQ
1249	Mansura	offensive	Loius IX	MQ

* this may be Harim, although William identifies Harim by its proper name elsewhere (Casalia seems otherwise unknown)

Abr.	Source	Range
AA	Albert of Aachen	(1100-1119)
AC	Annonyms Chronicle	(1100-1234)
AF	Abu'l-Fida	(1100-1250)
BD	Baha' al-Din	(1163-1193)
BH	Bar Hebraeus	(1100-1250)
ER	*Eracles*	(1184-1250)
FC	Fulcher of Chartres	(1100-1127)
IA	Ibn al-Athir	(1100-1239)
ID	'Imad al-Din	(1174-1193)
IQ	Ibn al-Qalanisi	(1100-1160)
ME	Matthew of Edessa	(1100-1137)
MQ	al-Maqrizi	(1174-1250)
MS	Michael the Syrian	(1100-1200)
US	Usama ibn Munqidh	(1100-1183)
WT	William of Tyre	(1100-1184)

Types of Thirteenth-Century Artillery, as Specified by Muslim Sources[1149]

Year	Site	Term	Number	Source
1218	Damietta	*shaytani*		Ibn al-Dawadari
		gharbiya		Ibn al-Dawadari
1229	Baalbek	*maghribi*		al-Ansari
1232-33	Shayzar	*maghribi*	1	Ibn Wasil; Ibn al-'Adim
1236	Harran	*maghribi*	1	Ibn al-Muqaffa
1236	Edessa	*maghribi*	1	Ibn al-Muqaffa
1248-49	Homs	*shaytani*	12	Ibn Wasil; al-Ansari
		maghribi	1 of 14	Ibn Wasil; al-Ansari
		qarabugha	1 of 14	Ibn Wasil
1265	Caesarea	*ifranji*	4?	Ibn 'Abd al-Zahir; Ibn al-Furat
		maghribi		Ibn 'Abd al-Zahir; Ibn al-Furat
1266	Safed	*maghribi*	>1	Ibn 'Abd al-Zahir; Ibn al-Furat
1275	al-Bira	*ifranji*	23 of 70	Ibn Shaddad; al-Yunini; Shafi' ibn 'Ali
1285	Margat	*shaytani*	4 of 10	Ibn 'Abd al-Zahir
		ifranji	3 of 10	Ibn 'Abd al-Zahir
		qarabugha	3 of 10	Ibn 'Abd al-Zahir
1286	Saone	*ifranji*	3 offensive, 1 defensive	Ibn 'Abd al-Zahir
1289	Tripoli	*ifranji*	6 of 19	Ibn al-Dawadari; al-Yunini; Ibn al-Furat
		qarabugha	13 of 19	Ibn al-Dawadari; al-Yunini; Ibn al-Furat
1291	Acre	*shaytani*	52 of 72	al-Jazari; al-'Ayni; al-Yunini; Ibn al-Furat
		ifranji	15 of 72	al-Jazari; al-'Ayni; al-Yunini; Ibn al-Furat
		qarabugha	(5?) of 72	al-Jazari; al-'Ayni; al-Yunini; Ibn al-Furat

Baybars' Use of Artillery, According to Ibn 'Abd al-Zahir

Date	Site	Intention	Use	Description (if provided)
1265	al-Bira	defensive	prepared	
1265	Caesarea	offensive	prepared, used	*maghribi* and *ifranji*, 4 large, small
1265	Arsuf	offensive	used	
1266	Safed	offensive	prepared, used	1 *maghribi*, others
1266?			prepared	
1268	Beaufort	offensive	prepared, used	26
1271	Crac	offensive	used	
1271	Akkar	offensive	prepared	some large
1272	'Akkar	defensive	prepared	
1272-73	Alexandria	defensive	prepared	

[1149] Adapted primarily from Chevedden, "Artillery of King James I," pp. 61-63 nn. 33-36.

Appendix 3.
Mathematical Scenarios

The following data sets have been calculated by Mark Denny using variables recommended to him based on the findings of this study. The formula that he has developed calculates the ideal mechanical ratios for given masses and beam dimensions, as well as sling lengths (Ls) and the corresponding release velocities (V) and angles of release (α), in order to effect a maximum horizontal range (Rh).[1150] Beam lengths (Lb) have been selected between 4 m and 10 m, counterweight masses (Mcw) up to 4,000 kg and projectile masses (Mp) between 10 kg and 70 kg. For each scenario the load angle of the beam (θ) is 135°, a reasonable balance between maximising the effective distance that the counterweight can fall and a practical axle height relative to the other components of the engine. A trough for the projectiles to slide on horizontally before being lifted has been factored in. The small beam ratios, between 2:1 and 3.4:1, reflect the reasonable beam lengths and counterweight masses. The beam in each case has a density of 750 kg/m^3 and an originally circular cross-section, 0.5 m in diameter, but which has had the left and right sides shaved down so the beam is no more than 0.3 m wide, shedding mass but retaining its vertical thickness and strength. The mass of the beam significantly decreases velocity when coupled with a relatively light counterweight, hence a beam no longer than 6 m has been paired with a counterweight of 1,000 kg. These mathematically determined figures should then be compared with those generated by reconstructed engines.

[1150] See Denny, "Siege Engine Dynamics," pp. 563-76; Denny, *Ingenium*, pp. 70-90.

70 kg Projectiles

Mcw	*Mp*	*Lb*	Lla	Lsa	Ls	V	~α	Rh
4,000 kg	*70 kg*	*10 m*	7.1 m	2.9 m	6.4 m	51.7 m/s	45°	250 m
4,000 kg	*70 kg*	*8 m*	5.7 m	2.3 m	5.1 m	48.7 m/s	45°	220 m
4,000 kg	*70 kg*	*6 m*	4.3 m	1.7 m	3.9 m	44.4 m/s	45°	190 m
4,000 kg	*70 kg*	*4 m*	2.9 m	1.1 m	2.6 m	38.0 m/s	45°	140 m
3,000 kg	*70 kg*	*10 m*	6.9 m	3.1 m	6.1 m	43.7 m/s	45°	180 m
3,000 kg	*70 kg*	*8 m*	5.6 m	2.4 m	5.0 m	41.5 m/s	45°	170 m
3,000 kg	*70 kg*	*6 m*	4.2 m	1.8 m	3.7 m	38.2 m/s	45°	140 m
3,000 kg	*70 kg*	*4 m*	2.8 m	1.2 m	2.5 m	33.0 m/s	45°	105 m
2,000 kg	*70 kg*	*10 m*	6.7 m	3.3 m	5.6 m	32.7 m/s	45°	105 m
2,000 kg	*70 kg*	*8 m*	5.4 m	2.6 m	4.6 m	31.9 m/s	45°	100 m
2,000 kg	*70 kg*	*6 m*	4.1 m	1.9 m	3.5 m	29.9 m/s	45°	90 m
2,000 kg	*70 kg*	*4 m*	2.7 m	1.3 m	2.4 m	26.4 m/s	45°	70 m

50 kg Projectiles

Mcw	*Mp*	*Lb*	Lla	Lsa	Ls	V	~α	Rh
4,000 kg	*50 kg*	*10 m*	7.2 m	2.9 m	6.5 m	56.3 m/s	45°	290 m
4,000 kg	*50 kg*	*8 m*	5.8 m	2.3 m	5.2 m	53.9 m/s	45°	270 m
4,000 kg	*50 kg*	*6 m*	4.4 m	1.7 m	4.0 m	49.6 m/s	45°	235 m
4,000 kg	*50 kg*	*4 m*	2.9 m	1.1 m	2.6 m	43.1 m/s	45°	180 m
3,000 kg	*50 kg*	*10 m*	7.0 m	3.0 m	6.2 m	48.0 m/s	45°	220 m
3,000 kg	*50 kg*	*8 m*	5.7 m	2.3 m	5.1 m	46.0 m/s	45°	200 m
3,000 kg	*50 kg*	*6 m*	4.3 m	1.7 m	3.9 m	42.8 m/s	45°	175 m
3,000 kg	*50 kg*	*4 m*	2.9 m	1.1 m	2.5 m	37.4 m/s	45°	135 m
2,000 kg	*50 kg*	*10 m*	6.7 m	3.3 m	5.7 m	36.7 m/s	45°	130 m
2,000 kg	*50 kg*	*8 m*	5.5 m	2.5 m	4.8 m	36.0 m/s	45°	125 m
2,000 kg	*50 kg*	*6 m*	4.2 m	1.8 m	3.7 m	34.0 m/s	45°	115 m
2,000 kg	*50 kg*	*4 m*	2.8 m	1.2 m	2.5 m	30.4 m/s	45°	95 m

30 kg Projectiles

Mcw	*Mp*	*Lb*	Lla	Lsa	Ls	V	~α	Rh
4,000 kg	*30 kg*	*10 m*	7.3 m	2.7 m	6.6 m	62.5 m/s	40°	345 m
4,000 kg	*30 kg*	*8 m*	5.9 m	2.1 m	5.3 m	60.2 m/s	40°	330 m
4,000 kg	*30 kg*	*6 m*	4.5 m	1.5 m	4.1 m	56.4 m/s	40°	290 m
4,000 kg	*30 kg*	*4 m*	3.0 m	1.0 m	2.7 m	50.1 m/s	40°	230 m
3,000 kg	*30 kg*	*10 m*	7.0 m	3.0 m	6.2 m	53.4 m/s	40°	260 m
3,000 kg	*30 kg*	*8 m*	5.8 m	2.2 m	5.2 m	52.1 m/s	40°	250 m
3,000 kg	*30 kg*	*6 m*	4.4 m	1.6 m	4.0 m	49.2 m/s	40°	130 m
3,000 kg	*30 kg*	*4 m*	2.9 m	1.1 m	2.6 m	43.9 m/s	40°	180 m
2,000 kg	*30 kg*	*10 m*	6.8 m	3.2 m	5.9 m	41.6 m/s	40°	160 m
2,000 kg	*30 kg*	*8 m*	5.5 m	2.5 m	4.9 m	41.2 m/s	40°	160 m
2,000 kg	*30 kg*	*6 m*	4.3 m	1.7 m	3.9 m	39.7 m/s	40°	150 m
2,000 kg	*30 kg*	*4 m*	2.9 m	1.1 m	2.6 m	36.2 m/s	40°	130 m

10 kg Projectiles

Mcw	*Mp*	*Lb*	Lla	Lsa	Ls	V	~α	Rh
3,000 kg	*10 kg*	*10 m*	7.2 m	2.8 m	6.5 m	59.5 m/s	40°	320 m
3,000 kg	*10 kg*	*8 m*	5.9 m	2.1 m	5.4 m	59.5 m/s	40°	320 m
3,000 kg	*10 kg*	*6 m*	4.5 m	1.5 m	4.1 m	57.8 m/s	40°	300 m
3,000 kg	*10 kg*	*4 m*	3.1 m	0.9 m	2.8 m	54.1 m/s	40°	270 m
2,000 kg	*10 kg*	*10 m*	7.0 m	3.0 m	6.2 m	47.0 m/s	45°	210 m
2,000 kg	*10 kg*	*8 m*	5.7 m	2.3 m	5.1 m	47.4 m/s	45°	210 m
2,000 kg	*10 kg*	*6 m*	4.4 m	1.6 m	4.0 m	46.9 m/s	45°	210 m
2,000 kg	*10 kg*	*4 m*	3.0 m	1.0 m	2.7 m	44.7 m/s	45°	190 m
1,000 kg	*10 kg*	*6 m*	4.1 m	1.9 m	3.5 m	30.7 m/s	45°	90 m

Appendix 4.
Reconstructed Trebuchets

Most reconstructed trebuchets are of the counterweight type. The majority of those built to be 'historically accurate' use Honnecourt's illustration (**Fig. C3**) as a plan for the base, while Viollet-le-Duc's nineteenth century hypothetical drawings (**Figs. H3** and **H4**) have influenced the superstructures of many. Among those drawing inspiration from these sources include those built by Favé at Vincennes, Radim Zepletal in Czechoslovakia, Peter Vemming Hansen in Denmark, the engines at Cardiff and Caerphilly in Wales and Beffeyte's hinged engine built at Urquhart Castle on Loch Ness, Scotland. Tarver's traction trebuchet is largely based on the illustrations and descriptions of al-Tarsusi, supplemented by the illuminations in the Morgan Bible (**Figs. B19** and **B20**). The much heavier Danish traction trebuchet was inspired by the engines found in BNF MS 10136 (**Figs. B21** and **B22**).

Abbreviations

Mcw	Mass of the counterweight (kg)
Mp	Mass of the projectile (kg)
Mb	Mass of the Beam (kg)
Lb	Length of the beam (m)
Lla	Length of the long arm (m)
Lsa	Length of the short arm (m)
Ls	Length of the sling (m)
Lcw	Length of the counterweight's centre of mass from the beam (m)
Lax	Height of the main axle (m)
Rmax	Maximum theoretical horizontal range (m)
Rh	Horizontal range (m)
V	True velocity of the projectile at release (m/s)
θ	Angle of the short arm to the vertical below the beam
α	Angle of release to the horizontal

Reconstructed Counterweight Trebuchets

Engine (measurements)	Lb	Lla	Lsa	Lcw	Ls	Lax	Mcw	Mp	Mb	θ	α	Rh	V
Favé, 1850 (Louis-Napoleon)	10.3 m	8.6 m	1.7 m				4,500 kg (1,500 fixed, 3,000 hung)	10.88 kg			~45°	175 m	*(>42 m/s)*
Caerphilly / Cardiff, 1990s (France [Fulton])	6.5 m	5.15 m	1.35 m			4.20 m	[2,000 kg]	[15 kg]		~115°	~45°	<100 m	*(~31 m/s)*
Danish, 1989 (Vemming, [France])	6.65 [6.5 m]	5.5 [5.5 m]	1.15 [1.0 m]	1.4 m	5 m	3.5 m	2,000 kg (capacity for 4,000 kg)	15 kg / 47 kg				168 m / ~85 m	*(>41 m/s) / (>29 m/s)*
Loch Ness, fixed, 1999 (Beffeyte)	8 m					7 m	6,000 kg	136 kg			(45°>25°)	200 m	56.1 m/s
Loch Ness, hinged, 1999 (Beffeyte)	15 m					7.2 m	6,000 kg (capacity for 11,000 kg)	136 kg	2,700 kg (0.6 m diam)		(45°>20°)	200 m	51.7 m/s
Castelnaud (Beffeyte)	15 m?						11,000 kg	113 kg				>250 m	*(>50 m/s)*
Chinese (Beffeyte)	11.4 m						5,600 kg	56 kg				212 m	*(>46 m/s)*
Helfstyn, 1986 (Krizek)	11.5 m					~8 m	6,000 kg (capacity for 10,000 kg)	100 kg (up to 300 kg)				200 m	*(>45 m/s)*
Hradec nad Moravici, 1990 (Krizek)	11.5 m					~8 m	4,000 kg	8-12 kg				445 m	*(>66 m/s)*
Warwick, 2005 (Busiakiewicz)							5,500 kg	15 kg				~200 m	*(>45 m/s)*

Reconstructed Traction Trebuchets

Engine (measurements)	**Lb**	**Lla**	**Lsa**	**Ls**	**Lax**	**Pullers**	**Mp**	**Rmax**
Tarver A, 1989 (Tarver)	4.88 m (16.0 ft)	4.18 m (13.71 ft)	0.70 m (2.29 ft)		3.66 m (12 ft)	8-25	1-8 kg	137 m (1.9 kg, 20 pullers)
Tarver B, (refit) 1991 (Tarver)	4.88 m (16.0 ft)	4.18 m (13.71 ft)	0.70 m (2.29 ft)	1.04 m (41 in)	3.66 m (12 ft)	14-16	3.9-5 kg	145 m (3.1 kg, 14 pullers)
Nykobing hybrid, 1991 (Vemming Hansen)	~8 m	6 m	~2 m (1.7 m to cw)		4.3 m	20		
Caerphilly (Fulton)						6-9	5-15 kg	~100 m

Tarver B - Trials[1151]

Trial	***Pullers***	***Mp***	*1*	*2*	*3*	*4*	*5*	*6*	*Avg.*	*Time*
1	**16**	***4.7 kg***	81 m	79 m	76 m	77 m	76 m	76 m	77.5 m	70 s (1/11.7 s, 5.1/ min)
2	**16**	***3.9 kg***	77 m	89 m	94 m	89 m	94 m	89 m	88.7 m	70 s (1/11.7 s, 5.1/ min)
3	**15**	***4.7 kg***	100 m	90 m	105 m	100 m	105 m	93 m	98.8 m	-
4	**4**	***3.1 kg***	65 m	68 m	52 m	55 m	55 m	69 m	63.0 m	75 s (1/12.5 s, 4.8/min)

*A further trial threw a 5 kg stone from the citadel of Damascus 83

[1151] Tarver, "Traction Trebuchet," p. 162.

Fig. I1 Tower of London: traction trebuchet

Fig. I2 Caerphilly Castle: traction trebuchet

Fig. I3 Caerphilly Castle: traction trebuchet (loading)

Fig. I4 Caerphilly Castle: counterweight trebuchet (loading)

Fig. I5 Caerphilly Castle: counterweight trebuchet

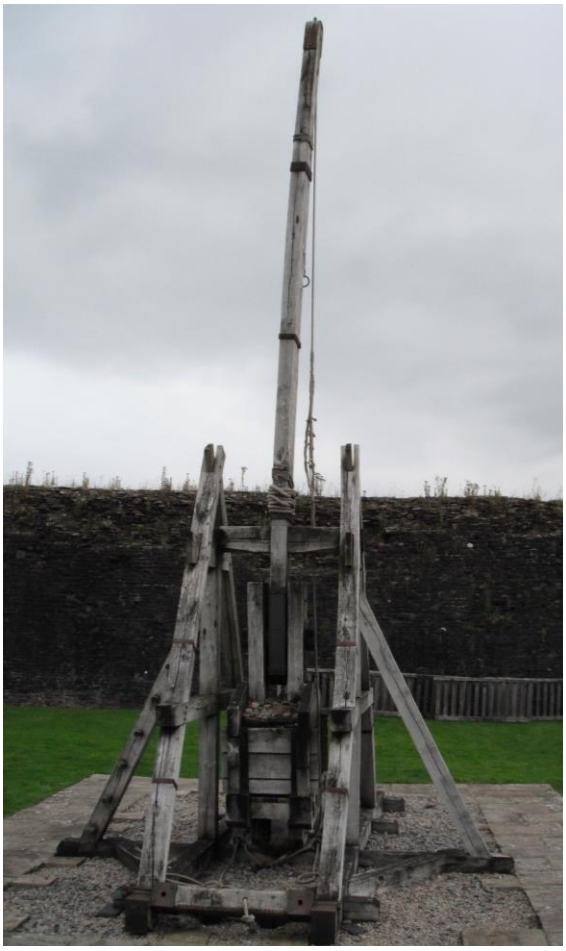


Fig. I6 Cardiff Castle: counterweight trebuchet

Fig. I7 Cardiff Castle: counterweight trebuchet (counterweight detail)

Fig. I8 Cardiff Castle: counterweight trebuchet (counterweight detail)

Fig. I9 Cardiff Castle: counterweight trebuchet

Appendix 5.
Al-Tarsusi's Persian Mangonel

I know of three translations of the text surrounding al-Tarsusi's Persian Mangonel (**Fig. C1**).[1152] The first was composed by Claude Cahen, who apparently translated each folio of the split-page text independently.[1153] Bernard Lewis's English translation of Cahen's edition has been provided.[1154] The second is by Paul Chevedden and was included as part of his 1986 PhD thesis, *The Citadel of Damascus*.[1155] The third is by Shihab al-Sarraf and is found in David Nicolle's chapter in *La Fortification au Temps des Croisades,* but is otherwise unpublished.[1156] All three have been included here to highlight certain interpretive differences, notably surrounding the role of the crossbow in the firing sequence. All three, however, confirm how primitive this engine was, or at least the author's understanding of it.

Bernard Lewis's Translation:

> *Description of a Persian Mangonel, Made for Me by Shaykh Abu'l-Hasan ibn al-Abraqi al-Iskandarani, with a Throwing Power of Fifty Pounds, More or Less*
>
> Its base is a crossbow (*jarkh*), and it is operated by a single man who makes the launch. When the man pulls the shaft, the hemp cords, which stretch the bowstring, reach its bolt; then the man catches the cup in a ring fixed to a strut which holds the shaft. Then he takes the bow and shoots and releases the shaft so that the stone is thrown.
>
> Take a Persian mangonel and set it up to make a launch. Dig a hole by the side of the pole, to a depth equal to the length of the hemp cords on the shaft. Then take a close-meshed hemp net and place at its ends three strong hemp ropes, long enough to reach from the top of the shaft, where the axle is, to the bottom of the hole; at the

[1152] For the original, see al-Tarsusi *Tabsirah Arbab al-Albab* (Oxford, Bodleian Library, MS Hunt. 264), ff. 134v-135r.
[1153] Claude Cahen, "Un traité d'armurerie," pp. 119-20, 142-43.
[1154] Lewis, *Islam*, 1:221-22.
[1155] Chevedden, *The Citadel of Damascus*, p. 278 n. 26 (on pp. 299-300).
[1156] Nicolle, "Early Trebuchet," pp. 275-76.

end of the shaft there should be an iron ring, to which the ropes attached to the net are tied; and in the net stones should be placed in a quantity corresponding to the strength of the men who pull the shaft. At the end of the shaft, by the cup rope, there should be two nails placed on a windlass hanging from the shaft. When the man pulls this shaft, after having placed the stone in the cup and tied the cup rope to the hook placed at the top of the shaft, he...the cup with an iron hook placed at its end in a ring fixed to a strut which supports the action of the net...its cord with the ropes which raise the net in a hook fixed to the ropes, and when the ropes rise with the net...the arrow in its course. He shoots and then immediately returns to the cup and releases it according to his judgement. There are various ways of pulling it. Here is a picture of it. One may pull the net by pulling the top of the shaft, since it swings back like a steelyard and can be pulled and caught. The crossbow should be placed at the bottom of the strut of the mangonel, on two iron hooks which hold it. One draws the bow string and pulls it toward the bolt on its course. When the man catches the cup in the strut, he takes the bow and holds it so that the net pulls the shaft. He brings it back to its position. This traction is stronger than that of men, since the net draws according to its proportion.

<u>Paul Chevedden's Translation</u>:

A Description of a Persian Trebuchet (*manjaniq farsi*), Made for Me by Shaykh Abu al-Hasan b, al-Abraqi al-Iskandarani, with a Throwing Power of Fifty Ratl (c. 200 lbs.), More or Less: At the base of its upright is a *jarkh* (crossbow/arbalest). All of that is pulled by a single man and he makes the launch. When the man pulls the beam, the hemp cords, which pull/stretch the bow-string, reach its bold/latch. Then the man fits the sling into a ring which is fixed to a base/pedestal which holds the beam. Then he takes the bow and shoot it; the beam is released and so the stone is thrown.

Take a Persian mangonel and set it up to make a launch. Dig a hole next to its upright to a depth equal to the length of the hemp ropes on the beam. Then take a net of close-meshed hemp and place at its ends three strong hemp ropes, long enough to reach from the top of the beam, where the fulcrum is, to the bottom of the hole. At the end of the beam there should be an iron ring to which the ropes, which are attached to the net, are tied. Stones should be placed in the net to a quantity equal to the force of the men who would [usually have to] pull the beam [of a traction trebuchet]. At the end of the beam, next to the rope of the sling, there should be a *mikhan* (hook?) placed on a pulley which hangs from the beam. The man pulls it (the beam) and after he places a stone in the sling and attaches the rope of the sling to the hook placed at the top of the beam. The man is able to pull the net (counterweight) by pulling the top of the beam, since it returns/swings back like the steelyard. After he pulls it (the beam), he attaches the sling to an iron hook placed at its (the beam's) lower end, [and put the sling] in a ring fixed to a base which holds the power/force (i.e. weight) of the net (i.e. counterweight). The crossbow is placed at the bottom of the base of the *manjaniq* in two iron hooks which hold it. The bowstring, with the ropes which raise the net, is put in a hook fixed to the ropes. When the ropes rise with the net, the ropes pull the bow string and convey it to the bolt on its course. After the man attaches the sling on the base, he takes the bow and places the arrow on its course and shoots it. Then he returns immediately to the sling and releases it according to his judgement. When the net (counterweight) pulls the beam, it brings it back to its [original] position; and [this] is stronger than the pulling (traction) of men, because it (the net/counterweight) pulls it (the beam) with a constant force, whereas men differ in their pulling force. And this is a picture of it.

<u>Shihab al-Sarraf's Translation</u>:

> A description of the Farsi type of *manjaniq* like that which I know was made by Shaykh Abu'l-Hasan Ibn al-Ibraqi al-Iskandari. It will have pulling (throwing) power of approximately fifty *artal* (92.5 kg if using the Syrian *rutl*, 20 kg if using an Iraqi *rutl*) and in the base of its support-frame there is a *jarkh* (crossbow). The entire operation is carried out by the (same man) who shoots it. Thus the man pulls the *saham* (literally "arrow" but also habitually used for the arm of beam-sling of the *mangonel*) by its hemp-ropes, and the string of the bow is in its lock and (the same man) attaches the *kaffah* (pouch of the sling) to a ring which is already fastened to the foundation (of the supporting frame) to secure the arm of the *manjaniq*. Take the bow (of the crossbow) and shoot it, which releases the arm of the *manjaniq* and thus throws the stone (missile). So take a Persian *manjaniq* but do not shoot with it (at once). Instead dig within the base of its frame a hole (in the ground) whose depth is equal to the length of the (pulling) ropes of the arm of the (ordinary) *manjaniq*. Then take a net of close interlaced ropes which has three cables of strong hemp rope from its upper part; their length being (the same as) that from the head of the *sahem* (the arm of the *manjaniq*) where the *khinzirah* (axle or fulcrum; literally female pig or 'sow') would be, to the bottom of the hole. There is an iron ring attached to the very end of the *saham* (beam-sling) of the *manjaniq*, so fasten the ropes from the net to this. Place in the net rocks (whose weight is) equal to the strength of the men who (would otherwise normally) pull the arm of the *manjaniq*. In the far end of the *saham* of the *manjaniq*, next to the rope of the pouch, there is a *mithan* (probably meaning loop) which is already put into a *bakrah* (reel or pulley) hanging from the *saham* of the *manjaniq*. The man pulls this after he places the rocks in the pouch (of the sling) and has attached its rope to the hook positioned in the head of the arm of the *manjaniq*. Thus the man has power (control) over the pull of the net and the pull of the head of the [*page break*] *saham* of the *manjaniq* equally, like the two arms of a balance (pair of scales). When it takes the strain, attach the iron hook which is in the lowest part of the pouch to the ring of 'that which makes it jump up' (the trigger) in the base (of the frame) to hold the weight of the net (containing the counterweight rocks). The bow of the *jarkh* (crossbow) is already placed in the lowest part of the frame of the *manganiq*, held in place by a pair of iron hooks. Attach its bowstring to the rope, which has lifted the net, by a hook fastened firmly to the ropes. That which has raised up the ropes of the net is thus pulled tight to the string of the bow which, as a result, is in the lock of the *majra* (the stock of the crossbow). Then the man holds the pouch (more likely meaning the net) down to the frame until it reaches the bow. Now place the *nablah* (arrow) in its groove (the crossbow stock) and shoot it. This releases the pouch which is consequently pulled up by the pull of the net (containing the counterweight) on the arm of the *manjaniq*. This will be more powerful than the comparable power of men pulling all at once because the men do not pull consistently

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